ALPINE SATELLITE DEVELOPMENT PLAN

VOLUME 1:
ABSTRACT, SUMMARY, TABLE OF CONTENTS, SECTIONS 1, 2, 3, 4, 4A, 4B

FINAL
ENVIRONMENTAL IMPACT STATEMENT

Prepared by

U.S. Department of the Interior

Bureau of Land Management

September 2004

The Bureau of Land Management Today

Our Vision
To enhance the quality of life for all citizens through
the balanced stewardship of America's
public lands and resources.

Our Mission
To sustain the health, diversity, and productivity of
the public lands for the use and enjoyment of
present and future generations.

Our Values
To serve with honesty, integrity, accountability, respect,
courage, and commitment to make a difference.

Our Priorities
To improve the health and productivity of the land
to support the BLM multiple-use mission.

To cultivate community-based conservation,
citizen-centered stewardship, and partnership
through consultation, cooperation, and communication.

To respect, value, and support our employees,
giving them resources and opportunities to succeed.

To pursue excellence in business practices,
improved accountability to our stakeholders,
and deliver better service to our customers.

BLM/AK/PL-04/017+3130+931

TABLE OF CONTENTS

LIST OF TABLES

PAGE

SECTION 1
INTRODUCTION

1.1 PURPOSE AND NEED

1.1.1 Intent of this Environmental Impact Statement (EIS)

The Bureau of Land Management (BLM) and four cooperating agencies — U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), U.S. Coast Guard (USCG), and the State of Alaska — have prepared the Alpine Satellite Development Plan (ASDP) Environmental Impact Statement (EIS) to examine ConocoPhillips Alaska, Inc.'s (CPAI, the applicant's) proposed action to develop five satellite oil accumulations in the northeastern National Petroleum Reserve-Alaska and the Colville River Delta adjacent to the eastern border of the National Petroleum Reserve-Alaska. The 890,000-acre Plan Area includes the Colville River Delta west of its easternmost channel and extends west to the vicinity of the mouth of the Kogru River on the west side of Harrison Bay and south from the Kogru River mouth for approximately 45 miles (Figure 1.1.1-1). This EIS examines the potential impacts of development and evaluates a range of alternatives, consistent with applicable law, by which to accomplish the purpose and need of the proposed action while mitigating adverse impacts to the greatest extent possible.

This EIS analyzes a proposal by CPAI to develop five satellite production pads — two in the Colville River Delta and three in the National Petroleum Reserve-Alaska. The pads are termed CD-3, CD-4, CD-5, CD-6, and CD-7. In the Colville River Delta, CD-3 is on State of Alaska land and CD-4 is on land owned by Kuukpik Corporation, the Native corporation created under the authority of the Alaska Native Claims Settlement Act (ANCSA) for the village of Nuiqsut. CD-5 is on land conveyed to Kuukpik within the National Petroleum Reserve-Alaska (NPR-A). CD-6 and CD-7 are on lands administered by the BLM in the National Petroleum Reserve-Alaska (Figure 1.1.1-2). CPAI proposes to place 20 to 30 wells on each pad and to transport the unprocessed, three-phase (oil, gas, and water) production to the existing Alpine Processing Facility (APF) at CD-1 for processing. Processed oil would be transported in the existing pipeline system to the Trans-Alaska Pipeline System (TAPS). The proposed action is more fully described in Section 2.

In addition to development proposed by CPAI, several alternatives analyze development options for pads, pipelines, and other facilities at a higher-than-project-specific level throughout the Plan Area in order to identify potential mitigation measures for future development in the area. Through this analysis, the EIS directly analyzes different development options for pads, pipelines, and other facilities in addition to those proposed by CPAI for oil development. It is important to note that no Preferred Alternative or Record of Decision will be developed for what is referred to in this EIS as the Full-Field Development (FFD) Scenario. Decisions on future proposals for developments in the area would be addressed through additional National Environmental Policy Act (NEPA) analysis. Such NEPA analysis could be an EIS or an environmental assessment (EA). An EA would be prepared for actions that are not anticipated to result in significant impacts. If significant impacts are expected or if an EA identifies significant impacts, an EIS will be prepared. For all EISs and for any less impacting proposal with potential controversy, local residents will be informed and involved. Also, readers should note that the pad locations described in Section 2 of this EIS for the FFD are hypothetical and do not reflect any actual proposals, applications, or project plans. The scenarios presented for FFD in Section 2 are presented for purposes of analysis and represent hypothetical potential future development within the next twenty years. While gas production through sales is considered speculative and is not part of CPAI's proposal, the effects of gas production as part of the oil stream and gas handling are considered.

1.1.2 Purpose and Need for the Proposed Action

The purpose of the Proposed Action is to allow CPAI to develop five satellite oil accumulations in the Plan Area. The need for oil production from the perspective of CPAI is to generate financial return on its investment in oil and gas leases.

Oil companies, but principally CPAI, have invested more than $100 million in leases in the Plan Area and have spent tens of millions of dollars more in seismic exploration, exploratory drilling, and scientific and engineering studies preparatory to development. Also, additional oil production on Alaska’s North Slope extends the useful life of the TAPS, in which the oil industry has invested many billions of dollars.

Federal and state governments allow development of valid federal, state, and private oil and gas leases consistent with applicable law and regulation. Furthermore, although not a purpose of CPAI’s proposal, development of these energy resources is consistent with broader national policies. Oil production from CPAI’s discoveries helps to satisfy the demand for a continued supply of domestic oil, to decrease dependence of the United States on foreign oil imports, and to contribute to employment and economic vitality in the region and nation.

The United States currently imports about half its oil supply, and the U.S. Department of Energy (DOE) projects that the proportion of the nation’s oil coming from overseas will continue to climb, approaching 68 percent by 2025. The DOE also reports that domestic oil and gas production in the United States overall is declining (DOE 2003). The DOE Office of Transportation Technologies reports that the trade deficit caused by oil imports represents a major transfer of wealth and jobs from the United States to foreign oil suppliers, stifling domestic economic growth (DOE n.d.).

Domestic oil production contributes directly to the health of the nation’s economy and to federal, state, and local government revenues. Oil production in Alaska is especially significant to the State of Alaska because it generates revenue to the state from jobs, investment, and royalties. Rentals and royalties from oil and gas leases contribute to the federal and state treasuries, as do taxes paid by oil companies and their workers.

The portion of the proposed action situated in the National Petroleum Reserve-Alaska helps satisfy the purpose of the Naval Petroleum Reserves Production Act of 1976 (NPRPA) to explore and develop oil and gas resources in the National Petroleum Reserve-Alaska. Specifically, the NPRPA, as amended, encourages oil and gas leasing in the National Petroleum Reserve-Alaska while requiring protection of important surface resources and uses. Development of the five satellite oil accumulations with appropriate environmental protection measures is consistent with the president’s directive to his National Energy Policy Development Group to “promote dependable, affordable and environmentally sound production of energy for the future” (National Energy Policy Development Group 2001). Furthermore, President Bush issued Executive Order 13212 on May 18, 2001, calling on federal agencies to give priority to energy-related projects: “For energy-related projects, agencies shall expedite their review of permits or take other actions as necessary to accelerate the completion of such projects, while maintaining safety, public health, and environmental protections.”

1.1.3 Lead and Cooperating Agency Authorities

This EIS is intended to fulfill the needs and obligations set forth by NEPA and other relevant laws, regulations, and policies of the BLM (lead agency) and of the USACE, USEPA, USCG, and the State of Alaska (cooperating agencies).

As the federal manager of the National Petroleum Reserve-Alaska, the BLM is responsible for land-use authorizations on federal land in the National Petroleum Reserve-Alaska. Upon completion of the EIS process, BLM will make decisions regarding CPAI’s proposal on lands it manages; these encompass CD-6 and CD-7 and facilities associated with them on lands eastward to the limit of federal lands. The authority for management of the land and resource development options presented in the EIS comes from several statutes, including

NEPA, the Federal Land Policy and Management Act (FLPMA), the NPRPA, as amended, and Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA).

- NEPA sets out policy and provides the means by which the federal government, including both the BLM and the federal cooperating agencies, examines major federal actions that may have significant effects on the environment, such as the authorization of oil and gas development contemplated in this EIS (42 USC § 4231 et seq.).

- Under the FLPMA, the Secretary of the Interior has broad authority to regulate the use, occupancy, and development of public lands and to take whatever action is required to prevent unnecessary or undue degradation of public lands (43 USC § 1732). In accordance with the FLPMA, the BLM manages its Alaska lands and their uses to ensure healthy and productive ecosystems.

- The NPRPA provides the Secretary of the Interior with the authority to conduct oil and gas leasing and development in the National Petroleum Reserve-Alaska (42 USC § 6508); protect "environmental, fish and wildlife, and historical or scenic values" in the reserve [42 USC § 6503(b)]; and provide "conditions, restrictions, and prohibitions as the Secretary deems necessary or appropriate to mitigate reasonably foreseeable and significantly adverse effects on the surface resources of the National Petroleum Reserve-Alaska" [42 USC § 6508(1)].

- The NPRPA also directs that development in designated Special Areas "shall be conducted in a manner which will assure the maximum protection of such surface resources to the extent consistent with the requirements of [the] NPRPA for the exploration of the reserve" [42 USC §§ 6504(b), 6508]. There are portions of two such Special Areas in the Plan Area — the Teshekpuk Lake Special Area (TLSA) and the Colville River Special Area (CRSA) (Figure 1.1.3-1).

- Title VIII of ANILCA establishes procedures for federal agencies to evaluate impacts on subsistence uses and needs and means to reduce or eliminate such impacts (16 USC § 3120).

The USACE has the authority to issue or deny permits for placement of dredge or fill material in the waters of the United States, including wetlands (which incorporate most, if not all, of the Plan Area) and for work and structures in, on, over, or under navigable waters of the United States. Consequently, the USACE's authority extends, and its decisions following completion of the EIS will extend, to CPAI's entire proposal, regardless of who owns the land.

- Under Section 404 of the Clean Water Act (CWA) (33 USC § 1251 et seq.), the USACE regulates placement of dredge and fill material in waters of the United States, including wetlands.

- Under Section 10 of the Rivers and Harbors Act (33 USC 403), the USACE has regulatory authority for work and structures performed in, on, over, or under navigable waters of the United States.

The USEPA authority to regulate oil and gas development is contained in the CWA (33 USC § 1251 et seq.), Clean Air Act (CAA) (42 USC § 7401 et seq.), and the Safe Drinking Water Act (SDWA) (42 USC § 300). Like the authority of the USACE, the USEPA'S authority extends, and its decisions following completion of the EIS will extend, to CPAI'S entire proposal, regardless of who owns the land.

- Under Section 311 of the CWA (33 USC §1251 et seq.), the USEPA requires a spill prevention, control, and countermeasure (SPCC) plan to be developed by owners or operators of any facility storing a total capacity of 1,320 gallons of fuel in aboveground storage tanks (AST). The SPCC plan describes the location of the fuel storage tank and methods of spill prevention to be implemented at the proposed facility. The SPCC plan must be developed and implemented before oil production begins (40 CFR 112).

- Under Section 402 of the CWA (33 USC §1251 et seq.), the USEPA issues permits for the discharge of pollutants from a point source into waters of the United States for facilities, including oil and gas facilities. Point-source discharges that require a National Pollutant Discharge Elimination System (NPDES) permit include, but are not limited to, sanitary and domestic wastewater, gravel pit and construction dewatering, and hydrostatic test water, storm water discharges, etc. (40 CFR 122).

- Under Section 404 of the CWA (33 USC §1251 et seq.), the USEPA reviews and comments on USACE Section 404 permit applications for compliance with the Section 404(b)(1) guidelines and other statutes and authorities within its jurisdiction (40 CFR 230).

- Under the SDWA (42 USC §300), the USEPA's responsibilities include the management of the Underground Injection Control (UIC) program and the direct implementation of Class I and Class V injection wells in Alaska for injection of non-hazardous and hazardous waste through a permitting process for fluids that are recovered from down hole, as well as municipal waste, stormwater, and other fluids that did not come up from down hole (40 CFR 124A, 40 CFR 144, 40 CFR 146). The USEPA oversees the Class II program delegated to the State of Alaska that is managed by the Alaska Oil and Gas Conservation Commission, which includes Class II enhanced oil recovery, storage, and disposal wells that may receive non-hazardous produced fluids originating from down hole, including muds and cuttings (40 CFR 147).

- Under Sections 165 and 502 of the CAA (42 USC §7401 et seq.), the State of Alaska is delegated authority to issue air quality permits for facilities operating within state jurisdiction for the Title V operating permit (40 CFR 70) and the Prevention of Significant Deterioration (PSD) permit (40 CFR 52.21) to address air pollution emissions. The USEPA maintains oversight authority of the state's program.

- Under Section 309 of the CAA (42 USC §7401 et seq.), the USEPA has the responsibility to review and comment on, in writing, the EIS for compliance with the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR Parts 1500–1508).

- Under Sections 3001 through 3019 of the Resource Conservation and Recovery Act (RCRA) (42 USC 3251 et seq.), the USEPA establishes criteria governing the management of hazardous waste. Although drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil, natural gas, or geothermal energy are solid wastes that are not hazardous waste in accordance with 40 CFR §261.4(b)(5), any other hazardous waste generated at the facility is subject to the hazardous waste regulations.

The USCG has authority under the Rivers and Harbors Act of 1899 to approve construction of any bridge across navigable waters to ensure safe navigability of waterways. The USCG exercises its authority to prevent unauthorized obstruction or alteration of the nation's navigable waters (33 USC 403). Within the Plan Area, USCG decisions will address any potential obstruction, including bridges, of the Colville River or its major distributaries.

The State of Alaska manages development on its land in the Colville River Delta on which one of CPAI's proposed satellites (CD-3) is located. The state has subsurface interest in both satellite locations in the Colville River Delta (CD-3 and CD-4). The state is responsible for regulating activities and developments on federal, state, and private lands that may affect air or water quality or resident species of fish and wildlife. The state also is responsible for providing subsistence use of fish and wildlife and to ensure consistency of activities and development with the Alaska Coastal Management Program (ACMP). In addition, the EIS studies development options that will help the state meet its responsibilities under various state statutes including Alaska Statutes (AS) Title 16 (Fish and Game), Title 31 (Oil and Gas), Title 38 (Public Land), Title 41 (Public Resources), and Title 46 (Water, Air, Energy, and Environmental Conservation). Consequently, following completion of the EIS, the State will make some decisions on the entire CPAI proposal, while it will make other decisions that rest with the land owner only on lands it manages at and near CD-3.

1.1.4 Other Agency Authorities

Several other federal, state, and local government agencies have authorities that apply to the proposed action and alternatives. These agencies include the U.S. Fish and Wildlife Service (USWFS), National Oceanic and Atmospheric Administration (NOAA) Fisheries (formerly National Marine Fisheries Service [NMFS]), and the North Slope Borough (NSB). Table 1.1.4-1 summarizes authorities that apply to the proposed action and alternatives. A more detailed description of the authorities is presented in Appendix C.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES

FEDERAL		
Legal Authority	**Authorizations**	**Regulatory Intent**
Federal Laws and Executive Orders Common To Multiple Federal Agencies		
National Environmental Policy Act (NEPA) 42 USC 4321	The NEPA of 1970 requires all federal agencies to prepare a detailed statement of the environmental effects of proposed federal actions that may significantly affect the quality of the human environment.	Protect the environment through procedures that ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.
Alaska National Interest Lands Conservation Act (ANILCA) 16 USC 410hh-3233 43 USC 1602-1784	Section 810: Federal agencies must evaluate and provide a proposed finding of effects of proposed development on subsistence.	Provide the opportunity for rural Alaska residents to continue to engage in a subsistence way of life.
National Historic Preservation Act (NHPA) of 1966 16 USC 470 et seq.	Federal agencies are responsible for ensuring protection of historical, cultural, and archaeological sites and resources in the USACE's permit areas.	Ensure consideration of the values of historic properties in carrying out federal activities. Make efforts to identify and mitigate impacts to significant historic properties.
Native American Graves Protection and Repatriation Act 25 USC 3001	Discovery or disturbance of any human remains in project area must be accounted for and protected and/or properly returned to the tribe of origin.	Protect Native American sacred and grave sites.
The American Indian Religious Freedom Act of 1978 42 USC 1996	Federal agencies must consider protection of sites considered sacred to Native Americans.	Reaffirm Native Americans' right to religious freedom, "including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites."
Executive Order 11988 – Floodplain Management	Federal agencies must establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for actions undertaken in a floodplain. Impacts to floodplains are to be avoided to the extent practicable.	Protect floodplains and manage risk from flooding.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (CONT'D)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
Federal Laws and Executive Orders Common To Multiple Federal Agencies		
Executive Order 11990 – Protection of Wetlands	Federal agencies must avoid short- and long-term adverse impacts to wetlands whenever a practicable alternative exists.	Protect wetlands.
Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Federal agencies must develop Environmental Justice (EJ) strategies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (including Native American tribes).	Protect the health and environment of minority and low-income populations.
Executive Order 13007 – Indian Sacred Sites	Federal agencies must accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sacred sites.	Protect and accommodate access to Native American sites.
Executive Order 13112 – Invasive Species	Federal agencies are to prevent the introduction of invasive species, control those that are introduced, and provide for the restoration of native species.	Prevent the introduction of invasive species and provide for their control.
Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments	Federal agencies must establish regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, strengthen the government-to-government relationships with Indian tribes, and reduce the imposition of unfunded mandates upon Indian tribes.	Encourage communication and active cooperation between the federal government and Native American tribal governments.
Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds	Federal agencies must avoid or minimize the impacts of their actions on migratory birds and take active steps to protect birds and their habitat.	Protect migratory bird habitat and populations.
Executive Order 13212 – Actions to Expedite Energy-Related Projects	Federal agencies must take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.	Increase production and transmission of energy in a safe and environmentally sound manner.
Bureau of Land Management (BLM)		
The Alaska Native Claims Settlement Act (ANCSA) 14 USC 33 1601-1629g	The BLM is responsible for transfer of federal lands to Native corporations and villages.	The ANCSA established Alaska Native land entitlements.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
Bureau of Land Management (BLM)		
Federal Land Policy and Management Act (FLPMA) 43 USC § 1732	Gives the BLM the authority to grant permits and regulate the use, occupancy, and development of the public lands and to take whatever action is required to prevent unnecessary or undue degradation of the public lands.	Provide for multiple use of public lands while protecting them from unnecessary or undue degradation.
Naval Petroleum Reserves Production Act 42 USC § 6500	Provides the secretary of the interior with the authority to lease and approve oil and gas development in the National Petroleum Reserve-Alaska while protecting the reserve's "environmental, fish and wildlife, and historical or scenic values."	Manage National Petroleum Reserve-Alaska "in a manner consistent with the total energy needs of the Nation, and for other purposes."
U.S. Army Corps of Engineers (USACE)		
Clean Water Act (CWA) of 1972 33 USC 1344	The USACE issues a Section 404 permit for discharge of dredged and fill material into U.S. waters, including wetlands.	Minimize impacts to waters of the United States (including wetlands) by regulating the discharge of dredged and/or fill material.
Rivers and Harbors Act of 1899 33 USC 403	The USACE issues a Section 10 permit for structures or work in, or affecting, navigable waters of the U.S.	Prevent unauthorized obstruction or alteration (dam, dike, or other structure) of any navigable waters of the United States.
U.S. Environmental Protection Agency (USEPA)		
Clean Air Act of 1967, Amended 1977 (CAA) 42 USC 7401 et seq.	The USEPA conducts a review and evaluation of the Draft and Final Environmental Impact Statement (EIS) for compliance with Section 309 of the CAA. The USEPA maintains oversight of the Alaska Department of Environmental Conservation's (ADEC's) implementation of the federal Prevention of Significant Deterioration (PSD) program through its state implementation plan.	Protect and enhance the quality of the nation's air resources by controlling emissions of USEPA-designated air pollutants by stationary and mobile sources.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
U.S. Environmental Protection Agency (USEPA)		
CWA of 1972, Amended 1977 33 USC 1251 et seq.	The USEPA issues a National Pollutant Discharge Elimination System (NPDES) Permit and Fact Sheet under Section 402, Federal Water Pollution Control Act of 1972, as amended (CWA) for discharges of pollutants, including oil and gas, from a point source into water of the United States. Section 402 – NPDES Water Discharge Permit. The USEPA may issue coverage under AK-33-0000 for discharges of excavation, dewatering, stormwater, hydrostatic testing, and domestic wastewater discharge from temporary camps, or an individual permit covering these discharges could be issued (see Appendix M). Section 311 – The USEPA provides a Federal On-Scene Coordinator responsible for direction and monitoring of spills. The USEPA also issues a spill prevention, control, and countermeasure (SPCC) plan for storage of more than 1,320 gallons in aggregate in aboveground tanks with capacity of 55 gallons or more. Section 404 – The USEPA reviews and comments on permit applications for compliance with Section 404(b)(1) guidelines and other statutes and authorities within their jurisdiction.	The purpose of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. It prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 402 establishes guidelines for effluent discharges from point-sources to the waters of the United States and for the NPDES permitting program. Section 311 establishes procedures, methods and equipment, and other requirements for equipment to prevent the discharge of oil from non-transportation-related onshore and offshore facilities into or upon the navigable waters of the United States or adjoining shorelines. Section 404's purpose is to minimize impacts to waters of the United States (including wetlands) by regulating the discharge of dredged and/or fill material.
Comprehensive Environmental Response, Compensation and Liability Act and the Superfund Amendments and Reauthorization Act 42 USC 9601	The USEPA implements facility reporting requirements to state and federal agencies for releases of hazardous substances in excess of specified amounts.	Protect public health and the environment from risks posed by uncontrolled hazardous waste sites.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
U.S. Environmental Protection Agency (USEPA)		
Emergency Planning and Community Right-to-Know Act 42 USC 9601 40 CFR 255, 370, and 372	The USEPA implements facility reporting requirements to state and federal agencies for releases of hazardous substances in excess of specified amounts.	The prevention of an accidental release of an extremely hazardous substance from any facility and, in the event of a release, to provide a mechanism for emergency response through state and local emergency planning teams and emergency response plans.
Resource Conservation and Recovery Act of 1976 (RCRA) 42 USC 6901	The USEPA develops and implements regulatory programs to manage hazardous waste from generation until ultimate disposal, including issuing an identification number for any entity that generates hazardous wastes. Under the authority of RCRA, the USEPA also regulates underground storage tanks that store petroleum or certain chemical products.	The protection of human health and environment from the potential hazards of waste disposal, conservation of energy and natural resources, waste reduction, and environmentally sound waste management.
Safe Drinking Water Act (SDWA) 42 USC §§ 300f et seq.	The USEPA issues an Underground Injection Control (UIC) Class 1 Industrial Well permit for underground injection of Class 1 (industrial) waste materials.	The protection of the quality of public water supplies and all sources of drinking water. The UIC program (authorized by Part C of the SDWA) was established to provide safeguards so that injection wells do not endanger current and future underground sources of drinking water.
Toxic Substances Control Act 15 USC 2601	The USEPA develops and implements regulatory requirements for the testing of new and existing chemical substances and regulates the treatment, storage, and disposal of certain toxic substances.	The protection of human health and the environment from hazardous chemicals.
Executive Order 11514 – Protection and Enhancement of Environmental Quality	The USEPA reviews and evaluates the Draft and Final EIS for compliance with Council on Environmental Quality (CEQ) guidelines.	This Executive Order details the responsibilities of federal agencies and the CEQ in directing their policies, plans, and programs to meet national environmental goals.
U.S. Coast Guard (USCG)		
Rivers and Harbors Act of 1899 33 USC 403	The USCG approves construction of a bridge across navigable waters to ensure safe navigability of waterways.	Prevent unauthorized obstruction or alteration (dam, dike, or other structure) of any navigable waters of the United States.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
U.S. Department of Transportation (USDOT)		
Hazardous Materials Transportation Act 49 USC 1801-1819	Hazardous materials must be transported according to USDOT regulations.	The Secretary of Transportation must protect the nation adequately against risks to life and property that are inherent in the transportation of hazardous materials.
U.S. Fish and Wildlife Service (USFWS)		
Fish and Wildlife Coordination Act (FWCA) 16 USC 661 et seq.	The USFWS provides consultation on effects to fish and wildlife resources.	Ensure that fish and wildlife resources receive equal consideration to other project features.
FWCA of 1980 16 USC 2901	The USFWS consults with the state agency responsible for fish and wildlife resources to conserve or improve wildlife resources.	Conserve and promote conservation of non-game fish and wildlife species and their habitats.
Bald and Golden Eagle Protection Act 16 USC 668	The USFWS permits relocation of bald and golden eagle nests that interfere with resource development or recovery operations.	Protect bald eagle populations.
Marine Mammal Protection Act (MMPA) 16 USC 1361-1407	The USFWS issues a Letter of Authorization for incidental takes of marine mammals including polar bear and walrus.	Ensure that marine mammal populations are maintained at, or in some cases restored to, healthy population levels.
Migratory Bird Treaty Act 16 USC 703	The USFWS implements provisions of the Migratory Bird Protection Act.	Protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia.
Endangered Species Act of 1973 (ESA) 16 USC 1531	The USFWS provides consultation on effects to threatened or endangered species.	Protect wildlife, fish, and plant species in danger of becoming extinct, and conserve the ecosystems on which endangered and threatened species depend.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

Federal		
Legal Authority	**Authorizations**	**Regulatory Intent**
National Oceanic and Atmospheric Administration (NOAA) Fisheries		
FWCA 16 USC 661 et seq.	NOAA Fisheries (formerly National Marine Fisheries Service) provides consultation regarding effects on fish and wildlife resources.	Ensure that fish and wildlife resources receive equal consideration to other project features.
Magnuson-Stevens Fishery Management and Conservation Act 16 USC 1801-1883	NOAA Fisheries provides consultation on the effects on Essential Fish Habitat. Essential Fish Habitat includes habitats necessary to a species for spawning, breeding, feeding, or growth to maturity.	Protect fish habitats and populations.
MMPA 16 USC 1361-1407	NOAA Fisheries provides consultation regarding effects on marine mammals. NOAA Fisheries issues Incidental Harassment Authorization under the MMPA for incidental takes of certain protected marine mammals (ringed seals, bowhead whales, etc.).	Ensure that marine mammal populations are maintained at, or in some cases restored to, healthy population levels.
The ESA of 1973 16 USC 1531	NOAA Fisheries provides consultation on effects to threatened or endangered species.	Protect certain species of marine mammals and fish in danger of becoming extinct, and conservation of the ecosystems on which endangered and threatened species depend.
State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Department of Environmental Conservation (ADEC)		
Oil Pollution Act of 1990 33 USC 2701-2761 AS 46.04.030 18 AAC 75	The ADEC reviews and approves the Oil Discharge Prevention and Contingency Plan (ODPCP) and the Certification of Financial Responsibility for storage or transport of oil.	Protect the environment from discharges of oil and assure financial responsibility in the event of a discharge.
CAA of 1967, Amended 1977 42 USC 7401 et seq. (CAA) 18 AAC 50.300(a) 18 AAC 50.020(a)	The ADEC issues an Air Quality Control permit to construct and to operate. The ADEC issues a Title V Operating permit and a PSD permit for air pollutant emissions under CAA Amendments (Title V).	Protect and enhance the quality of the nation's air resources by controlling emissions of USEPA-designated air pollutants by stationary and mobile sources.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Department of Environmental Conservation (ADEC)		
SDWA 42 USC §§ 300f et seq.	The ADEC reviews and approves all public water systems including plan review, monitoring program, and operator certification.	Protect drinking water.
Authorities, Water Quality Standards, and Wastewater Treatment AS 46.03.020, 050, 070, 100 and 720	The ADEC issues a Class I Well Wastewater permit for underground injection of non-domestic wastewater under AS 46.03.020.050, and 100.	Protect drinking water.
CWA of 1972, Amended 1977 33 USC 1251 et seq.	Section 401 – The ADEC can review the Storm Water Discharge Pollution Prevention Plans.	Establishes guidelines for effluent discharges from non-point sources to the waters of the United States and the NPDES permitting program.
	Section 404 – The ADEC issues a Certificate of Reasonable Assurance for Section 404 Permits.	Minimize impacts to waters of the United States (including wetlands) by regulating the discharge of dredged and/or fill material.
	Section 311 – The ADEC can review all SPCC plans.	Establishes procedures, methods and equipment, and other requirements for equipment to prevent the discharge of oil from non-transportation-related onshore and offshore facilities into or upon the navigable waters of the United States or adjoining shorelines.
CWA of 1972, Amended 1977 33 USC 1251 Drinking Water Standards 18 AAC 72	The ADEC provides approval for domestic wastewater collection, treatment, and disposal plans for domestic wastewaters. The ADEC provides approval for treatment and disposal plans for industrial wastewaters.	Regulation of discharges to protect water quality.
RCRA of 1976 42 USC 6901 18 AAC 60.430. – AS 46.03.005, 010	The ADEC reviews and approves solid waste processing and temporary storage facilities plan for handling and temporary storage of solid waste on state lands.	The protection of human health and environment from the potential hazards of waste disposal, conservation of energy and natural resources, waste reduction, and environmentally sound waste management.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Department of Environmental Conservation (ADEC)		
Oil & Hazardous Substance Pollution Control 18AAC 75	The ADEC reviews and approves any road stabilizing chemical or additive prior to its use. 18 AAC 75.055 establishes leak detection system requirements for crude oil transmission pipelines.	Protect the environment from any potentially hazardous materials being spread on the ground or in sensitive areas.
Alaska Department of Fish and Game (ADF&G)		
The Fish and Wildlife Conservation Act of 1980 16 USC 2901	The ADF&G consults with the USFWS about fish and wildlife resources to conserve or improve wildlife resources.	Conserve and promote conservation of non-game fish and wildlife species and their habitats.
The Fish and Wildlife Conservation Act of 1980 16 USC 661 et seq.	The ADF&G provides comments and recommendations to federal agencies pursuant to the FWCA.	Ensure that fish and wildlife resources receive equal consideration to other project features.
Alaska Department of Natural Resources (ADNR)		
Alaska Coastal Management Program (ACMP) Act of 1977 AS 46.40 6, 6AAC 50, 80, & 85 6AAC 50, 80, and 85 Coastal Zone Management Act (CZMA) of 1972, as amended in 1976 16 USC 1451 et seq.	The ADNR conducts a Coastal Zone Consistency review and issues determination of consistency of proposed development within the coastal zone.	Provide a balance through its guidelines and regulations for conservation of the coastal zone along with the development and use of natural resources.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Department of Environmental Conservation (ADEC)		
Alaska Historic Preservation Act AS 41.35.010 to .240 NHPA of 1966 16 U.S.C 470 et seq. 36 CFR 800 Sections 106 and 110 The Archeological Resources Protection Act of 1979 16 USC 470	Section 106 of the NHPA requires consultation with the Alaska State Historic Preservation Office (SHPO) and, when there are effects on cultural resources listed on or eligible for inclusion in the National Register of Historic Places (NRHP), with the President's Advisory Council on Historic Preservation. The SHPO issues a Field Archaeology Permit for archaeological fieldwork on state lands. The SHPO would also be consulted by the USACE. The ADNR issues a Cultural Resources Concurrence for developments that may affect historic or archaeological sites.	Protect cultural and archaeological resources to ensure consideration of the values of historic properties in carrying out federal activities and to make efforts to identify and mitigate impacts to significant historic properties. The Archeological Resources Protection Act secures the protection of archaeological resources and sites on public and Indian lands and encourages the exchange of information between involved individuals and entities.
Public Land Act Material Sales AS 38.05.110	The ADNR issues a Material Sales Contract for mining and purchase of gravel from state lands.	Manage use of Alaska's land and water resources.
Permits AS 38.05.850	The ADNR issues Right-of-Way (ROW) and Land Use permits for use of state land, ice road construction on state land, and state waters.	
Mining Sites Reclamation Plan Approvals AS 27.19	The ADNR approves mining reclamation plans on state, federal, municipal, and private land and water.	
Establishment of Drilling Units AS 31.05.100, AS 31.05.110	The ADNR establishes drilling units covering oil pools where leases are held by more than one operator.	Require unit plans of operation to maximize equitable returns to leaseholders and royalty recipients.
Right of Way (ROW) Leasing Act AS 38.35.020	The ADNR Joint Pipeline office issues pipeline ROW leases for pipeline construction and operation across state lands. The ADNR Commissioner signs the leases and the State Pipeline Coordinator manages the leases. The ADNR Division of Oil and Gas issues Lease Operation approvals for oil and gas development on state leases.	Manage use of Alaska's land and water resources.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Department of Environmental Conservation (ADEC)		
Water Use AS 46.15	The ADNR Division of Land, Mining and Water Management issues a Temporary Water Use Authorization for water use necessary for construction and operations. The ADNR issues a Water Rights Permit for appropriation of a significant amount of water on other than a temporary basis.	Manage use of Alaska's land and water resources.
Fishway Act AS 41.14.840	Requires that an individual or governmental agency notify and obtain authorization from the ADNR for activities within or across a stream used by fish if the ADNR determines that such uses or activities could represent an impediment to the efficient passage of fish.	Protect fish migration and spawning habitat.
Anadromous Fish Act AS 41.14.870	Requires that an individual or governmental agency notify and obtain authorization from ADNR "to construct a hydraulic project or use, divert, obstruct, pollute, or change the natural flow or bed" of a specified anadromous water body or "to use wheeled, tracked, or excavating equipment or log-dragging equipment in the bed" of a specified anadromous water body.	Protect fish migration and spawning habitat.
Alaska Oil and Gas Conservation Commission (AOGCC)		
Alaska Oil and Gas Conservation Act AS 31.05 and 20AAC 25	Drilling Permits: AOGCC regulates the drilling of wells on "all land in the state lawfully subject to its police powers, including land of the United States and land subject to the jurisdiction of the United States.	Regulate the drilling and production of oil and gas resources, prevent contamination of fresh water, protect correlative rights, and prevent waste.
20AAC 25.080	Disposal Permits: Regulates disposal of RCRA exempt wastes using annular disposal.	Ensure that waste is isolated and contained, and fresh water (if present) is not contaminated.
40 CFR 147.100 20AAC 25.252	Injection permits: AOGCC administers the Class II portion of the Underground Injection Control (UIC) program. Authorizes permits for disposal injection into Class II wells.	Ensure that injection wells are properly constructed and that injected fluids are contained within the intended subsurface formation.

TABLE 1.1.4-1 AUTHORITIES APPLYING TO THE PROPOSED ASDP AND ALTERNATIVES (COND'T)

State		
Legal Authority	**Permit**	**Regulatory Intent**
Alaska Oil and Gas Conservation Commission (AOGCC)		
20AAC 25.402-460	Issues permits for enhanced oil and gas recovery. In conjunction with the USEPA, AOGCC may exempt fresh water aquifers as needed for Class II wells.	
20AAC 25.280	Issues sundry notices to authorize work on existing wells. AOGCC requires reservoir or pool development plans, verifies the function of custody transfer metering systems, reviews and approves well work and well abandonment.	Maximize recovery and conservation of petroleum products.
North Slope Borough (NSB)		
Alaska Coastal Management Program (ACMP) Act of 1977 AS 46.40	The North Slope Borough has a coastal management plan and participates in ACMP consistency reviews for projects located inside the coastal district. The NSB participates in ACMP consistency reviews for projects located outside the coastal district if the project may have direct and significant impacts on the coastal zone or resources.	The NSB involvement in the ACMP provides the opportunity to address uses sensitive to development and issues of local concern, accessing traditional and contemporary local knowledge in order to achieve a balance in conservation of the coastal zone and the development and use of natural resources.
NSB Land Management Regulations (NSBMC §§ 19.10.010 – 19.70.060	The NSB requires compliance with its zoning and permitting ordinances and issues permits for development, uses, and activities on land within the NSB.	The NSB regulates land uses and activities within the borough to provide for the protection of the health, safety, and welfare of NSB residents and to ensure compliance with environmental policies of local concern.

1.2 BACKGROUND

1.2.1 State and Arctic Slope Regional Corporation (ASRC) Leases

The State of Alaska and ASRC administer existing leases in the Plan Area. The leased lands are in or just west of the Colville River Delta and lie east of BLM-managed lands in the National Petroleum Reserve-Alaska. State lands in the Colville River Delta were first leased in 1964 under Sale 13. The Alaska Department of Natural Resources (ADNR) has continued to hold lease sales in the Colville River Delta: Sale 23 in 1969, Sale 43A in 1984, Sale 54 in 1987, Sale 75 in 1992, and Sale 75A in 1993. The state has prepared "best interest findings" for sales since 1979. Before holding a state oil and gas lease sale, the ADNR Division of Oil and Gas is required to determine whether the sale serves the best interest of the state. In making this determination, the state solicits input from agencies and the public. For areawide sales, the ADNR prepares one best interest finding, which remains in effect for 10 years and offers all available acreage each year for the life of the finding. If substantial new information becomes available, the ADNR issues supplements to the finding. In 1998, the ADNR prepared an areawide best interest finding for the NSB. The Colville River Delta falls within the North Slope Areawide Sale boundaries and will be offered each year through 2008.

The Arctic Slope Regional Corporation (ASRC) is the subsurface land owner, and Kuukpik Corporation holds the surface estate to Native-owned lands resulting from ANCSA. ASRC also shares some subsurface estate with the State of Alaska in the Colville River Delta. The percent interest varies by lease. ASRC administers leases that existed at the time they became the subsurface owner of lands that were previously federally owned. ASRC has also sold additional leases for its subsurface estate acquired under ANCSA.

1.2.2 Northeast National Petroleum Reserve-Alaska IAP/EIS and BLM Leases

The BLM initiated the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan (IAP)/EIS in 1997 to determine the appropriate multiple-use management of the 4.6-million-acre Northeast Planning Area of the National Petroleum Reserve-Alaska, consistent with existing statutory direction for its management. All BLM-managed lands in the Plan Area were encompassed in the Northeast Planning Area. The agency's Record of Decision (ROD) for the IAP/EIS (BLM and Minerals Management Service [MMS] 1998b) authorized leasing and provides management direction for oil and gas development on federal land in the Plan Area.

The BLM conducted lease sales in the Northeast National Petroleum Reserve-Alaska in May 1999 and June 2002. The 1999 lease sale resulted in the sale of 133 tracts for $104.6 million. The BLM sold 60 tracts for $63.8 million at the 2002 lease sale. Leases for 82 of the 110 tracts in the Plan Area were sold in 1999 for a total of nearly $71 million, and 10 tracts in the Plan Area were sold in 2002 for $1.8 million. Of the leased tracts in the Plan Area, CPAI is the sole or leading leaseholder in 75 leases; Anadarko is the sole owner of four of the remaining 17 leases in the Plan Area. Chevron USA, Inc., and ConocoPhillips Company (a company distinct from, but affiliated with, CPAI) jointly hold 13 leases in the Plan Area. Eighteen tracts in the Plan Area have not been leased.

The ROD for the ASDP EIS may authorize modifications or exceptions to the requirements of the Northeast National Petroleum Reserve-Alaska IAP/EIS. These modifications or exceptions will be limited to those necessary for the development authorized by the BLM following completion of this EIS and will not constitute a general amendment of the IAP/EIS. An amendment of the IAP/EIS is currently being evaluated by the BLM through the preparation of a separate EIS that will be completed subsequent to the ROD for this EIS. For more discussion of this amendment now under consideration, see Section 4G.4.6.

1.2.3 Future Potential Kuukpik Corporation/ASRC Conveyance in National Petroleum Reserve-Alaska

In accordance with ANCSA provisions, Kuukpik Corporation is entitled to select and receive title to approximately 22,000 acres of federal land. Kuukpik Corporation will receive the surface estate to its lands, and, under the terms of ANCSA, ASRC will receive the subsurface estate. All available federal land in Kuukpik Corporation’s entitlement area is within the National Petroleum Reserve-Alaska and the Plan Area, and all of this federal land subject to Kuukpik selection was leased in 1999. Following Kuukpik Corporation’s selection, the BLM will convey to the corporation all valid selections up to the amount of the corporation’s entitlement. These conveyances include lands upon which currently proposed or future proposed oil and gas development may occur. Once the lands are conveyed, the BLM may transfer lease administration to ASRC for any leases that are completely encompassed by the conveyance “unless there is a finding by the Secretary that the interest of the United States requires continuation of the administration by the United States” (43 CFR 2650.4-3). The BLM will retain jurisdiction for leases that are only partially conveyed. ASRC would become the successor in interest to any and all interests of the United States for any leases that it assumes as a consequence of a conveyance of the underlying estate under ANCSA.

1.2.4 Oil Exploration and Development in the Plan Area

Before the 1923 establishment of the Naval Petroleum Reserve-4 (NPR-4), the predecessor of the National Petroleum Reserve-Alaska, private firms staked approximately 117 claims in the reserve. None were in the Plan Area, though several claims were staked not far to the west along the south shore of Teshekpuk Lake. No records exist of any exploration of these claims (BLM and MMS 1998a).

Encouraged by oil seeps in the region, the U.S. Navy began oil and gas exploration in the reserve in 1944 and continued this work until 1952 (King 1994). The Navy began another drilling program in the National Petroleum Reserve-Alaska in 1975, and the Department of the Interior (DOI) continued this program through the U.S. Geological Survey (USGS) after administration of the reserve was transferred to its authority in 1976. The DOI continued this drilling program until 1982. In the Plan Area, the Navy drilled one well northwest of the confluence of Fish and Judy Creeks, and the DOI drilled four sites, including one near the Navy well and three close to the Beaufort Sea coast or the south bank of Kogru River (BLM and MMS 1998a).

In the early 1980s, in the wake of completion of the TAPS and the development of Prudhoe Bay and other North Slope oilfields, the BLM sold leases in the National Petroleum Reserve-Alaska. Private oil firms conducted extensive seismic exploration of the National Petroleum Reserve-Alaska and drilled some exploratory wells on leases they purchased in these sales. None of the wells were drilled in the Plan Area, and all of these leases expired without development.

The first commercial discovery of oil in the Plan Area was the Alpine field in the Colville River Delta. Atlantic Richfield Company (ARCO) and its partners discovered the field in the winter of 1994–1995 (Alaska Report 1996), and subsequent appraisal drilling confirmed its original oil in place (OOIP) reserve potential of 365 million barrels (Alaska Report 1997). The field is currently estimated to contain 429 million barrels (OOIP). Alpine is the largest field discovered in Alaska since the discovery of the Point McIntyre field in 1988 and one of the largest fields discovered in the United States in recent decades. The Alpine infrastructure built by ARCO, a predecessor of CPAI, is composed of two drilling pads: CD-1 and CD-2. CD-1 contains the APF as well as production wells. CD-2 is a production pad. A road and pipeline link the two pads. Both CD-1 and CD-2 are accessed by air, with a landing strip that was constructed as a wider portion of the road connecting the two pads. They may also be accessed in the winter by ice road. In November 2000, Phillips Alaska, Inc., (successor to ARCO Alaska, Inc., and predecessor to CPAI) began production at Alpine, which is the westernmost producing oilfield on Alaska’s North Slope.

In November 2000, Phillips Alaska, Inc., began the process to permit two satellite oil and gas accumulations near Alpine in the Colville River Unit (CRU): CD-3 (called CD North during exploration) and CD-4 (formerly CD South). On May 21, 2001, Phillips announced several discoveries of oil and gas accumulations on its leases in the Northeast National Petroleum Reserve-Alaska Plan Area. Subsequently, the USACE, which had initiated evaluation of CPAI’s permit applications for CD-3 and CD-4, and the BLM determined to cooperate to evaluate the proposed development in the National Petroleum Reserve-Alaska and in the Colville River Delta through the current ASDP EIS.

1.3 TIERING

This EIS has been prepared in accordance with regulations and guidance of the CEQ (40 CFR 1500-1508). Subsection 1502.20 encourages lead agencies to “tier off their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review.” The BLM has followed that approach in this EIS by tiering off the Northeast National Petroleum Reserve-Alaska IAP/EIS and other BLM EIS documents mentioned in this EIS. Relevant text from these documents is summarized and incorporated by reference where appropriate.

1.4 ISSUES

The BLM and the cooperating agencies have sought to define the issues in the Plan Area through public participation and discussions with tribes (the Native Village of Nuiqsut, the Native Village of Barrow, and the Inupiat Community of the Arctic Slope [ICAS]), the NSB, the local government of Nuiqsut, and other federal agencies. (The BLM’s consultation and coordination efforts are further described in Section 5 of this EIS.) In this public scoping process, input was received from residents of the NSB, Anchorage, and Fairbanks; interested individuals from throughout the nation; businesses with an interest in oil and gas development; and individuals and groups with an interest in the environment.

The BLM and cooperating agencies have reviewed concerns and questions raised during the scoping process. Responsive solutions to many of those concerns and questions were integrated into elements of the alternatives developed for consideration in this EIS. The major issues and concerns raised during scoping generally fall into the categories below:

- **Adherence to Stipulations Identified in the Northeast National Petroleum Reserve-Alaska IAP/EIS**. Many commenters stated that the restrictions and protections (stipulations) issued with the IAP/EIS were necessary for protecting the environment and urged that the proposed and future developments in the Plan Area adhere to the stipulations without exception.

- **Oil and Gas Development in National Petroleum Reserve-Alaska.** The development covered in this EIS is the first proposed by industry in the National Petroleum Reserve-Alaska. Proponents of oil and gas development note that the National Petroleum Reserve-Alaska was set aside for oil and gas development. They cite the need for new reserves on the North Slope and increased U.S. production. Many proponents support site-specific exceptions to stipulations to allow development of additional oil reserves.

- **Impacts to Local Residents and Traditional Subsistence-Use Areas**. CPAI’s proposed action and the broader FFD would represent the westernmost oil and gas development on the North Slope. Development in this area would be close to the community of Nuiqsut and within traditional subsistence-use areas. There is a concern that a “balance between the benefits of development and the costs to the environment and people” be maintained. Nuiqsut residents in particular expressed concern that traditional lifestyles may be changed by impacts to traditional subsistence-use areas and lifestyle changes brought about by employment opportunities within and outside of the community.

- **Colville River Delta Resources.** The Colville River Delta is the largest river delta on Alaska’s North Slope and is largely covered by wetlands. It is important to NSB residents for subsistence hunting and fishing and is recognized for its significance during critical life stages of waterbirds. The area is considered to have high potential for oil and gas resources and requires special consideration during design, construction, operation, and maintenance of oil and gas facilities.

- **Full-Field Development Analysis within the Plan Area.** Issues regarding expanding oil and gas development in the Plan Area ranged from appreciation that the BLM was looking at the impacts throughout the Plan Area to caution when looking at foreseeable future development outside of the applicant’s proposal.

- **Environmental Quality.** Concerns include air and water quality, oil-spill prevention and response, effects of activities and development structures on fish and wildlife and their habitat (including some habitat identified in Special Areas under ANILCA), and the effect of contaminants on fish, wildlife, and people. It is also a concern that impacts on environmental quality may have subsequent long-term impacts to local residents.

Table of Contents

PAGE

List of Tables

SECTION 2
ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

This section describes oil and gas development that is currently proposed by the applicant, CPAI, and is reasonably foreseeable to begin over the next 20 years within the ASDP, hereafter referred to as the Plan Area. Section 2.2 of this document presents a discussion of how alternatives were developed. Section 2.3 presents a description of features common to alternatives. Section 2.4 presents detailed descriptions of the alternatives and of FFD scenarios developed consistently with the themes of several alternatives. Section 2.5 presents a side-by-side presentation of the features of all alternatives in tabular format for ease of comparison. Section 2.6 describes alternatives considered but eliminated from detailed analysis. Section 2.7 presents a comparison of the impacts of alternatives. Section 2.8 discusses future inspection and monitoring. Finally, Section 2.9 provides a description of the need for further analysis under NEPA.

The proposed action consists of the ASDP for five satellite[1] production pads north, south, and west of the existing APF-1 at Colville Development Production Pad (CD-1).

The applicant's proposed action is described as Alternative A. Alternatives B, C, and D, which also fulfill the purpose and need of the proposed action, were presented and evaluated in the Draft EIS (DEIS), as was Alternative E, the No Action Alternative. Alternative E serves as a benchmark, enabling the public and decision makers to compare the magnitude of environmental effects of the action alternatives. The Final EIS (FEIS) presents Alternative F, the Preferred Alternative. It also presents an additional sub-alternative (C-2) to consider the impacts of utilizing a possible alternative access road proposed by the State of Alaska from the existing oilfields east of Nuiqsut. These alternatives cover the full range of reasonable development alternatives.

2.2 OVERVIEW OF ALTERNATIVES

2.2.1 Overview of EIS Alternatives and Permitting Process

The alternatives developed in this EIS respond to a request by CPAI to develop oil and gas leases it holds in whole or in partnership with Anadarko Petroleum Corporation. CPAI provided an initial description of its proposed action in September 2002 and refined it in the course of the development of the DEIS. CPAI submitted permit applications to the federal, state, and NSB permitting agencies on January 16, 2004, and a revision to those applications on January 30, 2004. CPAI provided additional clarification of its application to the USACE, which the USACE reflected in its Public Notice of Application for Permit (POA-2004-253-2) (See Appendix L) issued April 9, 2004. Alternative A as described in the FEIS reflects the applicant's proposed action as of March 2004.

The alternatives presented in the DEIS provide for development of all five oil accumulations proposed for development by CPAI. The decision BLM will make regarding the applicant's proposed action is limited to BLM-managed lands; i.e., CD-6 and CD-7 and roads and pipelines eastward from those pads to where BLM-managed land abuts Kuukpik Corporation land. The cooperating agencies will make permitting decisions within their respective authorities (see Section 1.1.3) on federal, state, and private lands.

NEPA regulations issued by the CEQ require the identification of an agency-preferred alternative in the FEIS, unless another law prohibits the agency from expressing a preference. The BLM, as the lead agency, and the

---

[1] In oil and gas terminology, a "satellite" is a separate hydrocarbon accumulation that shares processing facilities and infrastructure with a nearby established oil and gas development.

cooperating agencies for this NEPA process have reviewed the information in the DEIS, comments received on the DEIS, and other pertinent information. On the basis of this review, the BLM, with the involvement of the cooperating agencies, has developed the agency-preferred alternative described below. The BLM intends to issue permits for actions on lands it manages consistent with the analysis contained in this EIS. After consultation with the cooperating agencies, the BLM determined that the provisions of the Preferred Alternative (Alternative F) are most consistent with the cooperating agencies' regulations. The USACE, however, is prohibited by law from identifying a preferred alternative prior to issuance of its ROD on the applicant's pending permit application. Accordingly, although the BLM has involved the USACE in its decision-making process to identify the Preferred Alternative, the regulation dictates that the USACE must reserve its decision pending issuance of the FEIS and its own independent review.

To be approved, CPAI's applications must be consistent with the requirements of the agencies' regulations. The agencies are reviewing the applications and additional information provided by the applicant as part of their permit review. The agencies will develop their decision documents, including RODs and permits, based on (1) findings of this review, and (2) additional information contained in the FEIS.

2.2.2 CPAI Development Plan Alternatives

Alternatives to the CPAI proposed action presented in the DEIS were developed based on public comments from public scoping comments, tribal consultation, and the purpose and need of the proposed action. (The alternatives are summarized in Table 2.2.2-1.) Most comments focused on specific options for different design components of the applicant's proposed action (for example, gravel roads instead of aircraft, pipelines of different heights, etc.). When grouping these components into action alternatives, the BLM conducted a series of working meetings with the cooperating agencies to develop a range of "themes" under which to place the various potential components. Each theme represented a certain goal, such as maximizing local economic benefit, minimizing environmental and cultural impacts, focusing on subsistence and community needs, and maximizing the safety and reliability of the development. The components selected for inclusion in each theme supported the theme's respective goal.

TABLE 2.2.2-1 ALTERNATIVES

Alternatives	Themes
A	**Applicant's Proposed Action:** This is the CPAI project as proposed.
B	**Conformance with Stipulations:** All activities must be conducted and facilities sited in accordance with the ROD for the Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations.
C	**Alternative Access Routes:** This alternative has two Sub-Alternatives, both of which include alternate road routes and bridge locations to those proposed in the ASDP. A road connection to Nuiqsut and higher pipelines are included. Under Sub-Alternative C-2, some access roads and bridge locations have been changed from the locations in Sub-Alternative C-1 to reflect access to National Petroleum Reserve-Alaska via the proposed State Colville River Road.
D	**Roadless Development:** This alternative has two Sub-Alternatives. Under Sub-Alternative D-1, the production pads would be developed with gravel airstrips. Under Sub-Alternative D-2, the production pads would be developed with gravel helipads. Gravel roads would be limited to those roads necessary for access from the airstrips or helipads to the drill sites.
E	**No Action:** CPAI would not be authorized to develop the five oil accumulations for which they have applied. No new oil and gas production or processing facilities would be developed in the near future in the Plan Area. Production, operation, and eventual abandonment would occur at the existing facilities (CD-1 and CD-2).
F	**Agency Preferred Alternative:** This is the agency preferred alternative. It requires that bridges over the Nigliq Channel and the Ublutuoch River be from bank to bank* and that their approaches provide for natural flow. It relocates the road to CD-4, accommodates natural water flow and fish passage, and removes substantial infrastructure from the 3-mile Fish Creek Buffer Zone. This alternative also requires that all powerlines be on cable trays, that the pipelines be 7 feet above the tundra, and that lighting on higher structures address bird strike issues.

Notes: * "bank to bank" is explained in detail in Section 2.4.6.5

Many components were common to multiple themes and many of the themes could be combined without conflict among the respective goals. The BLM grouped design components and themes that were not in conflict into discrete alternatives. The grouping of components and themes into discrete alternatives was accomplished by applying these themes and associated design components to the applicant's proposed action. This activity produced the set of alternatives introduced in Section 2.1 and described in more detail in the following text.

This "component approach" addressed a range of alternatives for individual elements of the applicant's proposed action, such as production pad access by gravel road or gravel airstrip, powerlines on power poles or cable trays mounted on vertical support members (VSMs), and specific roadway routing and river crossing locations. These components were combined into complete concepts based on unifying themes. For example, Alternative C includes a roadway connection to Nuiqsut and other features that would enhance Nuiqsut economic development and subsistence-hunting access to the development area, and roadless development Alternative D includes other components intended to minimize surface disturbance.

Following the public comment period on the DEIS, BLM and the cooperating agencies created the Preferred Alternative and a new sub-alternative of Alternative C. The Preferred Alternative and Sub-Alternative C-2 respond to comments received during the comment period and are further variations of components and themes considered within the range of alternatives presented in the DEIS. They are described at 2.2.2.3 and 2.2.2.6, respectively.

A discussion of alternative components that the BLM considered but eliminated from detailed analysis is provided in Section 2.6. These components either were suggested by members of the public, tribes, or agency representatives during the scoping process or are options that have been considered in other North Slope developments.

2.2.2.1 Alternative A – Theme: Applicant's Proposed Action

This description is consistent with the applicant's proposed action as of March 2004. Five production pads, CD-3 through CD-7, would be built, and produced fluids would be transported by pipeline for processing at APF-1. The five proposed pad locations correlate with former CPAI exploratory well locations, as indicated in Table 2.2.2-2. Gravel roads would connect CD-4 through CD-7 to the existing Alpine Field road. CD-3 would be constructed with a gravel airstrip but without a gravel access road. Gravel used for construction of roads, pads, and airstrips would be obtained from the existing ASRC Mine Site and the Clover Potential Gravel Source (Clover) (referred to as Clover A Mine Site in Appendix O). A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. Aboveground pipelines would be supported on VSMs and would be at elevations of at least 5 feet above the tundra. Powerlines in general would be supported by cable trays placed on the pipeline VSMs. Cable trays would not hang below the pipelines. Industry, local residents, and government would use the gravel roads. CD-6 and its access road and pipelines and the powerline from CD-6 to CD-7 would be within a 3-mile setback from Fish Creek, in which the BLM's Northeast National Petroleum Reserve – Alaska IAP/EIS ROD (BLM and MMS 1998b) (Stipulation 39[d]) (see Appendix D) prohibits permanent oil facilities. This alternative would provide an exception to this provision to allow location of CD-6 and its associated road and pipeline and the powerline within the setback. Additional exceptions would be required to locate oil infrastructure within 500 feet of some water bodies (Stipulation 41) and to locate roads between separate oilfields (Stipulation 48). In addition, although BLM does not interpret the first sentence of Stipulation 48 to apply to the applicant's proposed action (i.e., the agency does not consider the road between CD-1 and CD-2 or the additional road to CD-4 to constitute a connection to a "road system" outside the Northeast National Petroleum Reserve-Alaska planning area), out of an abundance of caution, if it is determined that this sentence applies in this case, the BLM would modify Stipulation 48 to allow the road from public land connecting to the existing road at APF-1. Finally, the USACE would have to determine that the applicant's proposed alternative for a road to CD-4 met the intent of Special Condition 10 of its 1998 permit that authorized the placement of fill associated with the construction of the Alpine Development Project. Special Condition 10 required roadless development in the Delta, unless an environmentally preferable alternative is available or roadless was infeasible, and that any alternative dependent on roads must be approved by the USACE as preferable to a roadless alternative. (See Appendix L for Special Condition 10.)

TABLE 2.2.2-2 PRODUCTION PAD NAMES FOR CPAI'S PROPOSED ACTION

Production Pad Name in this EIS	Former CPAI Exploration Well Designation
CD-3	Fiord or CD-North
CD-4	Nanuq or CD-South
CD-5	Alpine West
CD-6	Lookout
CD-7	Spark

Notes:
Existing CD-1 and CD-2 produce from the reservoir or hydrocarbon accumulation commonly referred to as "Alpine Field".
Proposed production pads CD-3, CD-4, CD-6, and CD-7 are near the locations of former exploration wells that tap reservoirs other than the Alpine Field. CD-5 will tap the Alpine Field.

2.2.2.2 Alternative B – Theme: Conformance with Stipulations

All activities would be conducted and facilities sited in accordance with Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations, as requested by many local residents and others. The location of CD-6 and its associated access road would be moved south, outside the 3-mile setback for Fish Creek. A gravel road would connect CD-4 with CD-1 and CD-6 with CD-7, but CD-3 and CD-5 would be roadless. Only CD-4 would be connected by road to existing Alpine Development Project. Airstrips would be required at CD-3, CD-5, and CD-6. Permanent oil infrastructure would be located at least 500 feet from water bodies to the maximum extent possible. Traffic on gravel roads would be open to industry and government and closed to local residents. The bridge crossing the Nigliq Channel near CD-2 would be for pipelines only. Powerlines would be buried in roads or at the toe of the slope of road, everywhere there is a road. Where there are no roads, powerlines would be buried in tundra adjacent to the pipelines. Powerlines would be hung off pipeline bridges at stream crossings and trenched across minor drainages**.** All other construction and operation strategies described for Alternative A would generally apply. The USACE would have to determine that the alternative for the road to CD-4 met the intent of Special Condition 10 of its 1998 permit that authorized the placement of fill associated with the construction of the Alpine Development Project.

2.2.2.3 Alternative C – Theme: Alternative Access Routes

Alternative C includes alternate road routes and bridge locations that differ from those proposed by the applicant. All pads would be accessed by gravel roads and would be sited in the same location as in Alternative A. Roads to CD-3 and CD-4 would connect to the Alpine Development Project. Roads to CD-5, CD-6, and CD-7 would connect to either the Alpine Development Project (Sub-Alternative C-1) via a road and pipeline bridge near CD-4 or to existing oilfields east of the Colville River using the state's proposed Colville River Road (Sub-Alternative C-2). To address interest by some local residents, both sub-alternatives would provide road access from Nuiqsut to the oilfields. To take better advantage of the state road under Sub-Alternative C-2, a bypass of Nuiqsut would be constructed from the state road to the satellite road of the applicant's proposed action (and the spur from the latter road to the north end of the village would be deleted) and an approximately two-acre pad would be added along the bypass primarily for vehicle storage. Powerlines would be hung from power poles. No new airstrips would be constructed. Aboveground pipelines would be supported on VSMs and would be at elevations of at least 7 feet above the tundra, as measured at VSM locations. (Local residents and others had requested pipelines be elevated more than the 5 feet proposed by CPAI.) Use of roads on BLM lands would be unrestricted; all other roads would be open to industry, local residents, and government only. Both sub-alternatives would require the same exceptions to BLM stipulations as Alternative A; however, Sub-Alternative C-2 would also require that BLM modify Stipulation 48 to allow connection of roads on BLM-managed lands with the state's proposed road. The USACE would have to determine that the roads to CD-3 and CD-4 meet the intent of Special Condition 10 of its 1998 permit that authorized the placement of fill associated with the construction of the Alpine Development Project.

2.2.2.4 Alternative D – Theme: Roadless Development

In Alternative D all gravel roads are eliminated and the production pads would be accessible only by air, ice road, and low-pressure vehicle. Air access would be via fixed-wing aircraft or helicopter. Because of different implications of the mode of air access**,** Alternative D is separated into Sub-Alternative D-1, fixed-wing aircraft access**,** and Sub-Alternative D-2, helicopter access. All pad locations would be the same as those for Alternative A, and this alternative would provide for the exceptions to Stipulations 39[d] and 41 of the Northeast National Petroleum Reserve-Alaska IAP/EIS. The pipeline crossing across the Nigliq Channel near CD-2 would employ horizontal directional drilling (HDD) in lieu of a pipeline bridge. Aboveground pipelines would be supported on VSMs and would be at elevations of at least 7 feet above the tundra as measured at VSMs. Powerlines between pads would be in cable trays mounted on the pipeline VSMs. All other construction and operation strategies described for Alternative A would generally apply.

2.2.2.5 Alternative E – No Action

Under this alternative, CPAI would not be authorized to develop the five oil accumulations for which it currently seeks authorization. No oil in the Plan Area, except that extracted from CD-1 and CD-2, would be produced in the near future, and no new roads, airstrips, pipelines, or other oil facilities would be constructed beyond what is authorized in connection with CPAI's current development at CD-1 and CD-2.

2.2.2.6 Alternative F – Preferred Alternative

The Preferred Alternative modifies key components of the applicant's proposed action to minimize, mitigate, or avoid certain potential environmental impacts identified by the BLM or the cooperating agencies or by the public through the NEPA process while achieving the purpose and need described in Section 1 of this EIS. The modified elements of Alternative F – the Preferred Alternative have either been adopted directly from alternatives analyzed in detail in the DEIS or reflect measures identified through the DEIS comment process or additional agency review of the applicant's proposal.

Alternative F modifies the applicant's proposed action (Alternative A) by the following:

- Requiring that the road and pipeline bridge across the Nigliq Channel extend from bank to bank
- Requiring that the road and pipeline bridge across the Ublutuoch River extend from bank to bank
- Requiring that approaches to both the Nigliq Channel and Ublutuoch River bridges provide for natural water flow
- Requiring that the road to CD-4 be either relocated around Lake 9323 or engineered to provide for natural water flow and fish passage
- Removing substantial infrastructure from the Fish Creek 3-mile setback, while allowing CD-6 to be located as requested by CPAI
- Increasing the elevation of pipelines to 7 feet minimum at the VSMs
- Requiring that powerlines between CD-6 and CD-7 be placed on cable trays
- Requiring lighting of higher structures to address bird strike issues

This alternative is described in greater detail in Section 2.4.6.

2.2.3 Full-Field Development Scenario

The concept of combining alternative development components into discrete development scenarios based on common themes also was applied to the identification of scenarios addressing reasonably foreseeable future oil and gas development throughout the Plan Area. In this manner, through this EIS process, the BLM, the cooperating agencies, other agencies, and the public will be better able to assess the total potential impact of development in the Plan Area and consider adoption of appropriate protective measures.

Potential production pad and processing facility locations were situated to allow consideration of effects to a wide range of environmental settings. Sites were located based in part on government and industry knowledge of oil resources, but purposely altered and masked to prevent revealing confidential or proprietary information. Sites were also located to ensure that a representation was provided of different habitats and use areas. This approach for locating sites was used to help elicit impact analysis of the widest range of potential impacts. The consequence was the identification of a number of hypothetical sites well beyond any present industry plan for development.

Once the potential sites were identified, the development themes and associated development components defined for the ASDP alternatives were used to construct comparable FFD scenarios. The resulting FFD scenarios explore a full range of potential environmental issues and encompass an aggressive level of potential development to help identify important environmental issues and associated mitigation measures that might be overlooked if a more limited review of the proposed action were implemented.

The FFD presented here is for analytical purposes only; no Preferred Alternative or ROD will be developed for FFD. The number and location of analysis sites were developed to protect proprietary geologic data, provide for consideration of potential impacts to a broad range of resources, and portray one of an infinite number of potential future development pictures. The BLM does not imply that development will or will not occur at any of these specific locations or on this scale. This analysis is not intended to result in agency approval of a specific FFD site analysis pad.

Although not proposed for development at this time, it is likely that currently undiscovered additional resources will be proposed for development in the Plan Area in the reasonably near future. This EIS examines various development approaches for FFD that are similar to those examined in each alternative for the proposed ASDP. Because they are similar to the FFD scenarios evaluated in other alternatives, no FFD scenarios are developed for Sub-Alternative C-2 or Alternative F. By examining these different FFD approaches, analyzing their impacts, and considering mitigation for them in the EIS process, the BLM and the cooperating agencies can provide the public and decision-makers with a more complete understanding of potential environmental issues associated with future potential long-term oil and gas development in the Plan Area. Any future proposal for development of the Plan Area will be subject to additional NEPA analysis. Such future analysis of impacts and potential mitigating measures will occur before issuance of any permits or approvals for future proposed oil and/or gas development in the Plan Area.

The FFD could entail development of additional production pads whose drilling product would flow back to the APF for processing or production pads that require additional hypothetical processing facilities (HPFs) at new locations in the Plan Area. It becomes technically challenging to transport three-phase produced fluids (oil, gas, and water) more than approximately 25 or 30 miles for processing. Therefore, FFD scenarios include new HPFs. The BLM has identified hypothetical locations for 22 production pads and two pads that would have both processing facilities and production wells. The actual location and number of production pads and HPFs that would be required to accomplish FFD are not known. The conceptual FFD portrayed and evaluated in this EIS is believed to overstate the anticipated FFD. CPAI projects that its leases, which cover the great majority of existing leases in the Plan Area, would not support more than a total of 12 production pads, including existing CD-1 and CD-2 and the five proposed pads. This analytical approach, however, is appropriate to address potential environmental issues at multiple locations where development could occur, given that the exact number, location, and future economic viability of future developments are not known. Figures presenting FFD scenarios show a circle around locations of each HP (hypothetical production Pad). The EIS considers the potential environmental issues associated with development within the entire Plan Area and specifically references the general area (the circle) rather than the specific facility site within the circles identified in the FFD scenario**.** Figure 2.2.3-1 is a map presenting the locations of the existing Alpine Development Project (CD-1 and CD-2), the locations of proposed production pads, and the approximate locations of the HPs and HPFs used in the FFD scenarios. The FFD HPFs would be similar to those described for the ASDP, and the HPFs would be similar to the APF. Other infrastructure in each scenario—roads, pipelines, powerlines, etc.—is anticipated to be similar to that described for the ASDP. Each FFD HP location is assumed to be able to extract 25 to 150 million barrels (MMbbl) of oil (50 MMbbl average); each pad with a processing facility is assumed to process 150 to 300 MMbbl of oil (250 MMbbl average). A sales oil pipeline from the HPFs would connect to APF-1 for transport of the sales oil to market via TAPS.

Although all production and processing facility pads, as well as roads and airstrips, are assumed to be constructed of gravel in a manner consistent with all other onshore North Slope oil and gas fields, the proposed gravel resources may not be adequate for FFD on the scale hypothesized. Consequently, for the FFD analysis, this EIS will examine the impacts of developing yet-unidentified additional gravel sources.

The following briefly describes the hypothetical scenarios for FFD examined in this EIS.

2.2.3.1 Alternative A – Full-Field Development Scenario

For the FFD scenario, two additional HPFs and 22 additional production pads could be constructed in the Plan Area. Gravel roads would connect all pads, except four in the lower Colville River Delta (downstream from the existing APF-1) and one pad near the Kogru River. Production pads not accessed by roads would be accessed by air; they would have gravel airstrips. Construction and operation strategies described for the applicant’s proposed action would apply for the FFD scenario. As noted above, exceptions to the stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS ROD would be necessary to allow placement of facilities in certain areas.

2.2.3.2 Alternative B – Full-Field Development Scenario

There are several major differences between Alternatives A and B relative to the FFD scenario. Pads would not be allowed in setbacks along Fish Creek, Judy Creek, the Colville River, and near the Kogru River in the Alternative B – FFD scenario. This restriction could result in either elimination of pads that could not be developed for technical or economic reasons from outside the setbacks or the relocation of pads to outside the setbacks and possible reduced production. Gravel road alignments would be altered so that they were outside of the setback areas. Networks of pads would be connected to the new HPFs, but no continuous road connection would be available for access to all pads. Airstrips would be constructed at all pads in the lower Colville River Delta, at the two HPFs, and at production pads not connected by roads to an HPF.

2.2.3.3 Alternative C – Full-Field Development Scenario

For the FFD scenario, airstrips would be built at the two HPFs. Gravel roads would connect all pads, including those in the lower Colville River Delta. Powerlines would be hung from power poles. Aboveground pipelines would be at elevations of at least 7 feet above the tundra, as measured at VSM locations. All other construction and operation strategies described for the Alternative A – FFD scenario would generally apply.

2.2.3.4 Alternative D – Full-Field Development Scenario

As with the development of the five proposed pads, Alternative D – FFD scenario would not include gravel roads between production pads and process facilities. Ice roads and/or low-pressure vehicles would be used more than in the other three action alternatives. All construction and operation strategies described for the proposed ASDP under Alternative D would apply. There are two options to this alternative, and they are reflected in the following scenarios:

SUB-ALTERNATIVE D-1 – AIRSTRIPS

Sub-Alternative D-1 would use fixed-wing aircraft to provide access to the proposed production pads and under FFD to HPs and HPFs. A gravel airstrip would be constructed at each production pad and process facility, including an apron/taxiway and an access road that would connect to the production or process facility pad. All airstrips are assumed to be 5,000 feet long to allow aircraft capable of flying in a relief rig. Drilling in the lower Colville Delta would be limited to the winter season.

SUB-ALTERNATIVE D-2 – HELIPADS

Sub-Alternative D-2 would use helicopters to provide access to the proposed production pads and under FFD to HPs and HPFs. A gravel helipad would be constructed at each production pad and process facility, immediately adjacent to the production or process facility pad. Drilling at all production pads would be restricted to winter only, when drilling crews, supplies, and if necessary, relief rigs could access the drilling site by ice road. Ice airstrips could be used to allow fixed-wing aircraft access to support construction or drilling operations. If an ice airstrip were in place, it could be used for relief rig access. Adopting the winter-only drilling program would result in a significantly extended development schedule for the applicant’s proposed action. This approach would require approximately six to seven winter seasons of drilling to complete a single production pad, rather than 1 to 2 years of year-round drilling. The winter-only drilling extends the FFD drilling schedule from approximately 25 years (including CD-3 to CD-7) to approximately 100 years. The associated intensity of manpower and resource use (water, gravel, etc.) would be reduced on a seasonal basis but would extend over many more years.

2.3 FEATURES COMMON TO ALTERNATIVES

This section provides descriptions of features that are common to several of the action alternatives. Specific descriptions of components that vary from the general descriptions presented in this section are presented in Section 2.4, Description of Alternatives.

2.3.1 Roads

2.3.1.1 Road Design

Roads are proposed to have a 32-foot-wide driving surface to accommodate two-lane traffic and wide-load moves such as drill rigs and modules (Figures 2.3.1.1-1, 2.3.1.1-2, and 2.3.1.1-3). They would be constructed with a minimum slideslope of 2-feet horizontal (H) to 1-foot vertical (V) (2H:1V). In areas subject to inundation, the potential for erosion exists, and necessary protection measures would be designed for the road slideslopes. Protective measures could include articulated concrete mat or gravel bags and are discussed further in Section 2.4.3.

The minimum depth of gravel roads would be 5 feet (Figures 2.3.1.1-2 and 2.3.1.1-3). This depth maintains the permafrost condition by insulating the tundra and offsetting the loss of insulating effect caused by compression of the vegetated tundra below the gravel and heat transmitted by the ground. On the North Slope, fill sections are used almost exclusively because cuts disturb the tundra mat, promoting thermokarsting (the melting of permafrost near the surface) and instability of the gravel structure. Tundra coverage and gravel volume estimates for typical roads were generated by using a 5.5-foot average depth to account for topographic variations and a slideslope of approximately 2H:1V.

Ideally, gravel used for road construction would be a clean, well-graded material free of ice and snow concentrations, overburden, clay or silt seams, and organic matter. The desired silt/clay fraction in the gravel is 15 percent (PN&D 2002b); however, actual pit run gravel would be used and it may vary from this specification. Less desirable gravel may require more grading maintenance and repair work or the use of advanced road construction techniques, such as chemical stabilizers and additives, sand bases with gravel caps, various synthetic geoproducts, insulation-founded roadbeds, interlocking steel mats, and constructing singlelane roads with pullouts for passing. These methods have not been proved as an alternative to the standard gravel road.

Road surfaces would be designed to be above a floodwater surface elevation for a 50-year return period plus 3 feet of freeboard (PAI 2002a). In addition to flooding and storm surges, other hydrologic factors will be accounted for during design, including scour protection, ice jams, drainage structure (bridge and culvert) requirements, and water body separation distances.

2.3.1.2 Road Construction

Roads would be constructed during winter. As shown in Table 2.3.1-1, road construction is the first step of the various construction activities required to build the infrastructure necessary for oil and gas production.

TABLE 2.3.1-1 TYPICAL CONSTRUCTION SCHEDULE FOR DRILL SITE DEVELOPMENT

Task	Year 1		Year 2	
	Winter	Summer	Winter	Summer
Lay gravel for road	X			
Lay gravel for drill sites	X			
Drilling operations			X	X
Install vertical support members for pipelines	X			
Install pipelines	X		X	
Install powerlines	X			
Install module piles	X			
Install bridge foundations	X			
Construct bridges			X	
Work gravel on pad/roads		X		
Install surface facilities			X	
Set modules			X	
Production startup				X

Note: This is one possible schedule. The drilling schedule and pipeline/road/bridge construction schedules are site dependent and program dependent.

The first step in gravel road construction for surveyors is to stake out the designed road alignment. Next, ice roads are built to provide transportation of equipment and trucks for gravel hauling. For lengthy roads, such as those that would be built in the proposed action, an ice road is usually constructed adjacent to the toe of the designed road. The ice road would be the minimum size necessary to allow a large truck to conveniently dump its load, turn around, and return to the gravel source.

The volume of gravel required to construct the typical North Slope road cross-section (Figures 2.3.1.1-1, 2.3.1.1-2, and 2.3.1.1-3) is approximately 41,100 cubic yards (cy) per mile of roadway, for a road with 5.0-foot average thickness, 32-foot-wide driving surface and 2H:1V slideslopes. If gravel were hauled by using trucks with a 40-cy capacity (typical for a B-70 haul unit), it would take approximately 1,030 truck round trips per mile of road built.

Roads would be built by using a bulldozer, B-70-type haul trucks, a grader, and vibratory compactors. Gravel placed during winter contains ice and therefore continues to settle through the following summer when it must be finish-graded and compacted to produce a stable driving surface. Regrading is not expected to require additional gravel. Material typically would be compacted from 90 to 95 percent of the maximum density. Maximum density is the measure of the maximum theoretical density achievable for a particular type of soil at the optimum moisture content.

2.3.1.3 Road Use During Operations

After completion of drilling operations, normal field operations would require approximately two round trips per day (once per shift), per roaded production pad, by truck from APF-1. In addition, there would be infrequent heavy truck traffic associated with maintenance and resupply. Normal road maintenance activities such as road watering would be implemented to control dust and protect the integrity of the roadbed.

To minimize potholes, roads would be graded periodically. Grading frequency would vary with weather and road conditions and with the number and weight of vehicles. Grading typically would occur twice a month during June through September. Care would be required while grading to prevent disturbance to the tundra adjacent to the road-fill slopes.

Winter maintenance would include snow removal for vehicle access and to prevent unnecessary runoff, road erosion, and tundra silting during the spring melt.

2.3.1.4 Road Abandonment and Rehabilitation

By the terms of federal and state leases and permits, it is the responsibility of the lessee/applicant to remove facilities and rehabilitate the land upon field abandonment or expiration of a lease or oil- and gas-related permit to the satisfaction of the land management authority. Abandonment plans would be developed at the time of abandonment or expiration of the lease or permit in consultation with appropriate local, state, and federal agencies and would be subject to federal (BLM, USACE, and/or USEPA) and state approval. The AO will take into consideration alternative uses for the infrastructure and the impacts of removing infrastructure and alternative means to rehabilitate the land. Federal agencies would undertake appropriate NEPA analysis of any such abandonment and rehabilitation decision at the time of abandonment or expiration of a lease or permit. All costs associated with abandonment, removal, and restoration are the responsibility of the lessee.

There is currently no estimate available of the economic life of CPAI’s proposed facilities, but it is likely to be consistent with the expected life of the Alpine Field, which may be several decades. Abandonment would occur when the cost of producing and transporting oil exceeds the market value of the oil.

The AO may require any of a range of abandonment and rehabilitation steps for roads. Among the most prominent possibilities, gravel roads may be:

- Removed, the gravel either placed back into gravel pits (restoration plans may need to be altered) or used for other development, and the area revegetated
- Left in place and maintained for continued use
- Revegetated either naturally or actively by the permittee and bridges and culverts removed and roads breached to facilitate more natural water flow

2.3.2 Pipelines

2.3.2.1 Pipeline Design

Pipelines connecting production pads to processing facilities would consist of elevated 16- to 24-inch-diameter, three-phase (oil, water, gas) production lines; 6- to 10-inch-diameter miscible injectant (MI) lines (MI is natural gas); 8- to 14-inch-diameter seawater injection lines; and 6-inch-diameter lift-gas lines (CPAI 2004a). Production pads that are not connected to processing pads by roads would also be served by 2-inch-diameter product supply lines that would carry diesel and mineral oil and occasional batches of chemicals (methanol, corrosion inhibitor, scale inhibitor, and emulsion breaker). The need for and potential quantity of the chemicals required would depend on operating experience after start-up. All pipelines would have a non-reflective finish. The pipelines would be insulated, except for the 2-inch line. A cross-section of a typical pipeline support system is shown in Figure 2.3.2.1-1.

For FFD, a U.S Department of Transportation (USDOT)-regulated 14-inch-diameter sales oil pipeline and a 12-inch-diameter seawater supply pipeline would be constructed on the same VSM supports as the in-field pipelines described above. A cross-section of a typical pipeline support system carrying these pipelines in addition to in-field pipelines is shown in Figure 2.3.2.1-2 These pipelines would extend from the APF to the FFD HPFs. They would have a non-reflective finish and would be insulated. The sales oil and seawater supply pipelines would include a pig launcher/receiver pair for each line segment. The pig launcher/receiver pair allows inspection and maintenance devices called pigs to be inserted into and removed from the inside of the pipeline. Launchers and receivers would be located inside modules on the gravel pads at the HPFs.

New pipelines would be constructed so that the bottom of the pipe elevation is a minimum of 5 feet above the tundra in two alternatives. Three other alternatives consider a minimum of 7 feet above the tundra, measured at the VSMs. Actual clearances could be greater than the minimum because of topography and the allowable rate of elevation changes for the pipelines. Minimum clearances above the tundra would include insulation, jacketing, and appurtenances to the pipelines, except for vibration dampeners. Vibration dampeners that could encroach into the minimum clearance space would be added to certain segments of the pipelines to minimize wind-induced stress. Dampeners typically could extend approximately 1.5 feet below the pipeline and would be spaced at the midpoint of each span of pipeline between VSMs (Borden 2003). In addition to the minimum height above the tundra, pipelines in the Colville River Delta would be designed with a minimum elevation of the 200-year return period plus 3 feet of freeboard (CPAI 2002a). The span between VSMs would be approximately 55 feet. Pipeline design would comply with the American Society of Mechanical Engineers (ASME) Codes B31.4 and B31.8 and CPAI internal standards. These standards are not strictly applicable to in-field pipelines, but Code B31.4 would be used as the design basis for water and oil pipelines and Code B31.8 would be used for gas pipelines.

Where roads are proposed between production and HPF pads, pipelines would parallel the roads. Pipelines generally would be placed 350 to 1,000 feet from the access road (at least 500 feet, if feasible, on BLM-managed lands), except at the bridge over the Nigliq Channel, where pipelines would be located on the downstream side of the road bridge structure. In the Colville River Delta, roads generally will be located upstream from the pipeline to help protect the pipeline from ice; elsewhere the road generally would be downstream from the pipeline to serve as a containment barrier in the event of a pipeline spill.

2.3.2.2 Pipeline Construction

Pipeline construction would take place from an ice road that would serve as a work pad for pipeline installation. Typically, the base width of the ice road would be approximately 40 feet, but the width would be increased if the vehicles or construction methods used require more width. Ice pad staging areas also would be constructed approximately every half-mile along the pipeline route. Staging areas would be 150 feet wide by 300 feet long and would be used to stage materials temporarily, provide turnaround areas for large trucks, and provide storage and work areas for refueling trucks, maintenance crews, and other support functions.

Borings for the VSMs would be drilled directly from the ice road by a heavy-duty, truck-mounted VSM drill rig. Alternatively, VSMs could be driven into the tundra by a pile driver. Cuttings from borings may be hauled to gravel source locations and deposited there as part of the reclamation plan, or may be used as fill for another project. The 20- to 25-foot-deep borings usually would be bored 3 to 4 inches wider than the VSM pipe. VSM pipe diameters would vary from 12 to 40 inches. Pier piles supporting pipeline bridges such as those proposed between CD-1 and CD-3 would range from 30 to 36 inches in diameter. Pipeline bridge abutment piles would range from 24 to 30 inches in diameter. After the VSM would be set in the boring, the annulus space would be filled with a sand-water slurry mixture and vibrated to evacuate air voids. The pile then would be allowed to freeze back naturally from the cold surrounding permafrost, which would take approximately 1 day. As soon as the pile would freeze in place, construction could continue and loads could be applied.

Horizontal-pipe-support cross beams, or horizontal support members (HSMs) (Figures 2.3.2.1-1, 2.3.2.1-2, 2.3.2.1-3, 2.3.2.1-4, 2.3.2.1-5), and insulated pipe sections would be shop-fabricated. Shop fabrication minimizes the waste material produced in the field and eases field assembly. Materials would be trucked to and staged along the pipeline route by conventional tractor-trailer trucks. There would be approximately 75 truckloads per mile of pipeline to transport VSM and pipeline construction materials.

The HSMs would be bolted or welded to the VSMs. The pipelines would be welded together while temporarily supported alongside the VSMs. Boom tractors would then lift long sections of assembled pipe into the pipe saddles mounted onto the HSMs. Pipeline construction typically would follow VSM installation by a lag of a few days, resulting in a single-season project. However, longer pipelines may require multiple seasons, resulting in VSM installation during one winter season, followed by pipeline installation during the next winter season (Table 2.3.1-1).

Throughout construction, welds would be tested for defects, and the completed pipeline would be pressure tested. Hydrostatic testing would be performed to ensure integrity of the pipe material, fittings, and welds. In general the pipeline would be filled with water and pressurized to a specified test pressure. The pressure would be maintained for a time period specified by code. At the end of the test, the water would be discharged from the pipeline. If fresh water is used, it would first be tested for contaminants and then discharged onto the tundra through a filter medium to remove any solids. The tundra would be protected so that erosion would not occur during the discharge. After testing, the water would be discharged in accordance with the General National Pollutant Discharge Elimination System (NPDES) Permit for Oil and Gas Extraction on the North Slope of the Brooks Range, Permit Number AKG-33-0000, which covers discharges from hydrostatic testing of pipelines. If seawater is used, it could be injected into the reservoir to maintain reservoir pressure or disposed of in a disposal well.

On rare occasions, pipeline hydrostatic tests could be conducted in the winter. In this case, freeze-protected water would be used. The options would be salt brine, glycol/water, or methanol/water solution. At the end of the test, the test fluid could be re-used for another purpose, injected for pressure maintenance, or disposed of in an injection well.

2.3.2.3 Pipeline Operation

Pipelines would be ready for start-up upon completion of hydrostatic testing. Production start-up would proceed in accordance with the schedule in Table 2.3.1-1. Pipeline segments connecting production pads with APF-1 would be placed into operation individually as the production pads are completed.

PRODUCTION PIPELINE

The production line would be three-phase, which means that the line carries a mix of oil, water, and gas. Three-phase flow in pipelines could cause “slugging,” wherein pressure pulses or vibrations occur when flow and pressure differences between gas and oil/water occur. This phenomenon is frequently a function of the pipeline elevation changes and/or erratic operating conditions of production wells. In the case of pipelines crossing rolling terrain, slugging occurs when liquid gathers at the lowest parts of the pipeline until it is forced onward through the rest of the pipe by the pressure of the gas caught behind the pooled liquid.

A central operations center at APF-1 would operate the production pipeline on a continuous basis. The operations center also would monitor conditions such as flow, pressure, and valve status (open or closed) to detect leaks or other upset conditions.

SEAWATER INJECTION PIPELINE

The seawater injection pipeline would carry treated seawater from APF-1 to the production pads. No seawater treatment plant (STP) is contemplated for the Plan Area. Instead, treated seawater would be piped from an existing treatment facility at Oliktok Point, through an existing seawater supply pipeline from the Kuparuk Oilfield to APF-1. Under FFD, the seawater supply pipeline would be extended from APF-1 to the HPFs. The seawater would be distributed from each processing facility to production pads through seawater injection pipelines, and then injected into the reservoirs to maintain pressure. Operation of the seawater injection pipeline also would be controlled from APF-1 operations center. Deoxygenation at the existing Oliktok Point STP would minimize the corrosivity of the water. In addition, the water would be treated periodically with a biocide or other chemicals in an effort to limit the potential of microbiologically influenced corrosion. The seawater injection pipelines to CD-5, CD-6, and CD-7 could also be used for produced water injection. For those production pads, CPAI could alternate the pipeline service between seawater and produced water.

MISCIBLE INJECTION PIPELINE

The MI pipeline would transport MI from APF-1 or, in the case of FFD, from an HPF to the production pads. The MI enhances oil recovery by acting as a solvent to flush oil out of the reservoir formation and by maintaining reservoir pressure. MI is produced gas that is blended to provide a specific composition (ethane, propane, etc.). The specific composition is dependent upon the reservoir the MI would be injected into. The normal operating pressure of the MI pipelines would be about 4,200 pounds per square inch.

LIFT GAS PIPELINE

The lift gas line would carry natural gas from the existing APF, or in the case of FFD, from an HPF to the production pads. Lift gas is produced gas that has been dehydrated. The lift gas would be injected into the annular space of production wells. From there, it would pass through valves into the produced fluids in the production tubing. Lift gas is injected to reduce the density of the produced fluids and thus help “lift” them out of the well and to the surface facilities. The operating pressure of the lift gas pipelines would be about 4,200 pounds per square inch.

PRODUCT SUPPLY PIPELINE

The 2-inch product supply line would be a non-insulated carbon steel line. The product supply line primarily would be used to transfer diesel and also could be used to transfer batch quantities of mineral oil, corrosion inhibitor, scale inhibitor, methanol, and emulsion breaker to production pads that are not served by gravel roads. The products would not be heated and the line would operate at ambient temperature. Because the ambient temperature is below freezing during most of the year, external corrosion is anticipated to be limited. Because this pipeline would be used to transfer finished products, it would be regulated under USDOT pipeline rules.

PIPELINE MAINTENANCE AND REPAIR

Maintenance and repair activities would be required during the operational life of the pipelines. These activities could include but are not limited to support adjustment, insulation repairs, corrosion repairs, and valve repairs. Most of these activities would occur with the pipeline in operation. In some cases, a pipeline shutdown would be required to make repairs and perform maintenance. Extended flow interruptions during winter would likely necessitate that produced fluids and seawater pipelines be evacuated and the contents displaced with appropriate gases or fluids. During extended pipeline shutdowns, wells would be freeze-protected and shut in.

Most planned maintenance and repair activities would occur during winter to allow ground access to pipelines on ice roads or frozen tundra. However, urgent repairs may require access when the tundra is not frozen. In these cases a helicopter, low-ground-pressure vehicle, or rig mats would be used. A typical maintenance and repair crew could range from 5 to 25 people.

2.3.2.4 Pipeline Abandonment and Rehabilitation

As noted in Section 2.3.1.4, removal of facilities and rehabilitation of the land is the responsibility of the permittee, and approval of the plan for removal and rehabilitation is within the discretion of the AO. Abandonment of the proposed pipelines could include demolition and removal of the facilities and restoration of disturbed ground. It is anticipated that pipeline removal would be consistent with that described for TAPS in the TAPS ROW Renewal EIS (TAPS Owners 2001a). On the basis of the pipeline removal for TAPS, it is assumed that abandonment could include:

- All aboveground pipelines, valves, and supporting structures would be removed to a depth that would prevent frost-heave action lifting the remnant to the surface.

- Any belowground pipeline segments would be cleared, cleaned of oil and other residues, capped, and left in place in locations where they would not interfere with other abandonment activities or planned land uses.

- APF and HPFs would be used as work camps and staging areas to support pipeline abandonment activities.

- Residual, surplus, and scrap materials would be reused or recycled to the extent possible, and waste materials would be disposed of in accordance with applicable regulations.

2.3.3 Production Pads

2.3.3.1 Production Pad Design

The following sections describe production pads proposed for the ASDP. The five production pads are known as CD-3, CD-4, CD-5, CD-6, and CD-7. Production pad design would be similar for FFD.

There would be three typical sizes of production pads. The road-connected production pads would be approximately 9.1 acres; non-road connected or roadless pads in the Delta areas would be approximately 12.6 acres; and other roadless pads would be approximately 17.6 acres. These pad sizes exclude associated airstrips, helipads, boat launch facilities, and access roads. Non-Delta roadless pads must be larger because equipment would be brought in over ice roads in winter and staged on the pad so that the pad could be self-sustaining during the summer months when roads access would not be available for transportation of heavy equipment (PAI 2002a). Because roadless pads in the Delta would support winter-only drilling, there is no need for an additional materials staging area. Production pads with no road access back to CD-1 during drilling would require additional pad space for a mud plant. This design is similar to that used for other recent production pad developments such as Tarn and Meltwater, east of the National Petroleum Reserve-Alaska (CPAI 2003a). Production pads would be designed with an orientation that minimizes wind-drifted snow accumulations, and would use natural slope or culverts to alleviate ponding. The CD-3 and CD-4 production pad layouts are presented in Figures 2.3.3.1-1 and 2.3.3.1-2.

The minimum production pad thickness would be 5 feet to maintain a stable thermal regime (see Section 2.3.1.1, Road Design, for discussion on thermal stability). The volume of gravel fill for a production pad would vary depending on site-specific topography and design criteria, but would be approximately 80,000 to 100,000 cy. Slideslopes would be at least 2H:1V. Potential for erosion would be evaluated on a pad-specific basis, and if necessary slideslope protective measures would be designed. Gravel quantity estimates in this section are based on a 5.5 to 6.0-foot pad thickness with slideslopes that are approximately 2H:1V. See Figure 2.3.3.1-3 for a typical satellite production pad layout, as would be applicable for CD-5, CD-6, and CD-7.

The existing production pads in the Colville River Delta have been designed to accommodate a floodwater surface elevation for a 200-year (Q_{200}) return period plus 1 foot of freeboard (PAI 2002a). Design thickness for the pads outside the Colville River Delta is driven by the permafrost protection criteria. Conceptual design for the proposed pads and HPs would be designed to the same criterion (Q_{200} plus 1 foot). Other hydrologic factors that would be considered in the detailed design to protect the structural integrity of the pads include scour protection, ice jams, storm surges, and separation distances from water bodies. (CPAI proposes a minimum separation of 200 feet.) On the basis of the elevation at the location of proposed CD-3 and hydrologic data, CPAI has estimated gravel quantities by using an average pad thickness of 5.5 feet, except for CD-4 which is 7.5 feet (CPAI 2004). Gravel quantities and acres of cover for the HPs north of CD-1 and CD-2 (CD-3, HP-5, HP-7, HP-12, HP-13, HP-14, and HP-22) were estimated by using these same average pad thicknesses.

Typical facilities on a production pad would include the following infrastructure:

- Approximately 20 to 30 wellhead houses

- Manifold piping
- Pig launcher/receiver building
- Production heater
- A communications building that doubles as an emergency shelter for operators stranded by inclement weather
- A permanent radio transmission tower up to 200 feet high at CD-7; 60-foot-high permanent towers at CD-3, CD-4, and CD-5; and a temporary radio tower up to 140 feet tall at CD-6. Permanent towers would be triangular self-supporting towers with 9-foot-wide bases or other design proven in previous North Slope use. The temporary tower would be pile supported. All towers would have warning lights. Similarly for FFD, there would be 60-foot towers at all production pads, except for 140-foot towers at HP-11, HP-12, HP-13, and HP-15 and 200-foot towers at HP-10, HP-14, HP-19, and HP-22.
- Spill response equipment container
- Emergency generator for roadless pads
- Temporary tanks, in secondary containment, to support drilling operations at road-connected pads:
  - Two 16,800-gallon (400-barrel [bbl]) brine tanks
  - One 8,400-gallon (200-bbl) cuttings and mud tank
  - A drill rig diesel fuel tank built in as part of the drill rig structure
- Additional temporary storage tanks in secondary containment for a roadless production pad, to support drilling operations:
  - Two 25,200 gallon (600-bbl) brine tanks
  - One 25,200-gallon (600-bbl) freshwater tank
- Production operations storage tanks, in secondary containment:
  - One 16,800-gallon (400-bbl) or smaller corrosion inhibitor tank
  - One 6,300-gallon (150-bbl) methanol tank
  - One 4,200-gallon (100-bbl) or smaller scale inhibitor tank
  - One 6,300-gallon (150 bbl) or smaller emulsion breaker tank
- Production operations stand-by tank (normally empty), in secondary containment, to support well and pad operational activities and maintenance, on an as-needed basis:
  - Two 500-bbl work tanks to facilitate well work
  - Well testing equipment
- Mud plant tanks and silos, to support year round drilling at a pad or cluster of pads that do not have gravel or ice roads access from CD-1:
  - Six 25,000-gallon (600-bbl) tanks (two for brine, three for mud, one for water)

  - Silo for bulk barite (mud weighting material)
  - Silo for gel (bentonite used to adjust mud rheology)
  - Silo for bulk dry cement
  - Mixing tank and equipment to mud and/or brine
  - Production operations storage tanks, in secondary containment:

    One 16,800-gallon (400-bbl) corrosion inhibitor tank

    One 6,300-gallon (150-bbl) methanol tank

    One 4,200-gallon (100-bbl) diesel fuel tank

    One 4,200-gallon (100-bbl) scale inhibitor tank

    One 6,300-gallon (150 bbl) or smaller emulsion breaker tank

- Production operations stand-by tanks (normally empty), in secondary containment, to support well and pad operational activities and maintenance on an as-needed basis:
  - Two 400-bbl waste oil and water recycle tanks for storm water and oil transfer
  - Two 500-bbl work tanks to facilitate well work

No major hydrocarbon processing facilities would be located at the production pads; all produced fluids would be transported by pipelines to processing facilities.

2.3.3.2 Production Pad Construction

Construction of production pads would begin by surveying and staking out the pad limits. For the road-connected pads, the gravel road first would be built directly to a point intersecting with the pad site. Pad construction would entail placing gravel off the end of the gravel road in a 24-inch initial lift (layer) until the entire footprint of the pad is covered. This initial lift would provide an area in which trucks to turn around and would enable the placing and compacting of successive lifts to proceed efficiently until the pad would be completed.

In the roadless scenario, an ice road would be built to transport equipment and haul the necessary gravel to build the pad structure. Pad construction would commence with placement of gravel off the end of the ice road in a 24-inch lift until the entire footprint of the pad would be covered (PN&D 2002b). Construction would proceed in winter months only, with construction access via the ice road.

Uneven thaw settlement caused by winter placement of gravel would necessitate remobilizing or leaving a grader and vibratory compactor on the pad until summer to regrade and compact the pad as the embankment thaws during the following summer. Poor quality gravel with high water content and organic matter would extend the amount of time required to compact the gravel adequately.

The number of haul trucks required would depend on the distance from the gravel source; that is, if the source were farther away, more haul trucks would be required to keep equipment working continuously. The distance to the gravel source would be especially important because the winter construction window is typically 5 months or less as a result of time constraints for tundra access during winter.

Under both the gravel road access and ice road access scenarios, construction crews would access production pads only by road. Construction crews would fly into APF-1 from the Kuparuk Oilfield. Construction crews for CPAI's five proposed production pads would be housed at APF-1 or at Nuiqsut. In FFD, construction crews might also be housed at a new HPF. Estimated North Slope manpower required for the applicant's proposed action during the construction phase is provided in Table 2.3.3-1. This estimate includes labor for all construction activities, not just pad construction. It has been assumed for the purposes of analysis for the five production pads, that there would be no difference in construction manpower requirements for the different ASDP alternatives.

TABLE 2.3.3-1 CONSTRUCTION AND DRILLING MANPOWER REQUIREMENTS

Time Period	Construction Craft and Staff Personnel	Drilling Personnel
Activity		5-Pad[1]
Summer 2004	50	0
Winter 2004/2005	550	75
Summer 2005	250	0
Winter 2005/2006	550	75
Summer 2006	300	60
Winter 2006/2007	400	75
Summer 2007	100	60
Winter 2007/2008	350	135
Summer 2008	250	60
Winter 2008/2009	250	135
Summer 2009	10	0
Winter 2009/2010	100	195
Summer 2010	200	120
Winter 2010/2011	200	195

Source: CPAI 2003n

Notes:

[1] Drilling manpower requirements reflect a maximum of 60 personnel residing at the temporary drilling camp at each of the four road-connected pads in the ASDP. Winter drilling at CD-3 requires an additional 15 people for a total of 75 personnel at that roadless location.

2.3.3.3 Drilling Activities at Production Pads

During construction and drilling, portable generators would provide temporary power as necessary. A drill rig and consumables would be driven to the production pads either across ice roads in the winter (CD-1) or on gravel roads. The drill rig would use reduced sulfur diesel-generated power, with reduced sulfur diesel fuel transported from APF-1 to the production pads by tank truck on gravel or ice roads, or to roadless production pads through the 2-inch-diameter products pipeline (CPAI 2003a). Development drilling would begin after production pads were constructed and would continue until all wells at a production pad were completed or until the drill rig needs to move to accommodate a seasonal drilling program, as with the proposed winter-only drilling at CD-3 and summer-drilling at CD-4. In the latter case, the drill rig would have to be remobilized to the production pad the following season to continue drilling.

The drill rig would be totally enclosed with wind walls and arctic winterization. The enclosure would retain heat to protect the mud pumps and associated engines, mud mixing and cleaning equipment, and diesel-driven generators. These winterization measures also provide noise abatement. Loading bins would be oriented to minimize noise impacts on adjacent areas.

A temporary modular camp for up to 75 workers (Table 2.3.3-1) would be established on each production pad during drilling to support 24-hour drilling operations (CPAI 2003a; CPAI 2003e). Camps would be utilized year-round until drilling is complete for CD-5, CD-6, and CD-7. Camps would be present during winter drilling at CD-3 and during summer drilling at CD-4. Wastewater discharges associated with the temporary camps would be limited to domestic wastewater (both graywater and sanitary waste).

In addition to camp water requirements, approximately 38,000 gallons per day (gpd) of water would be required to support drill rig and mud plant operations at each production pad location (CPAI 2003e). Water would be obtained from lakes for which permits have been obtained.

Drilling wastes (mud and cuttings) could be managed by a combination of methods: annular disposal into permitted development wells onsite; transport and injection into an approved Class II Disposal (Class IID) well at APF-1 or other North Slope operating unit; and reapplication of washed/tested gravels onto production pad and/or road surfaces. Associated regulatory guidance is described in Section 2.3.11.6. Drilling waste (mud, ground cuttings, excess cement, mix water, etc) is almost exclusively disposed of in annular disposal at the existing CD-1. Conservation Order 443 issued March 15, 1999 contains the pool rules for the Alpine Field. Findings 14-21 and conclusions 5 and 6 apply to annular disposal at the Alpine Development Project. CPAI projects that the lithologies and absence of underground sources of drinking water (USDWs) would be similar for the five new proposed CD sites; annular disposal would also be used for drilling waste disposal. As of the end of 2002, a total of 908,686 of drilling waste has been disposed of in 33 annuli on CD-1 and CD-2. The waste was from 68 wells. This volume gives an average of slightly under 13,400 bbl per well. 20 AAC 25.080 allows for a total of 35,000 bbl of waste to be disposed of in a permitted annulus. For comparison, at the end of 2002, the Alaska Oil and Gas Conservation Commission (AOGCC) records show that a total of 184,032 bbl of waste has been injected into CD1-19A (Class IID well) and 1,155,330 bbl of waste had been injected into WD-02 (Class I Disposal [Class ID] well).

A Class ID well is an injection well for disposal of non-hazardous waste or RCRA-exempt waste. Class ID wells are permitted and regulated by the USEPA through the UIC Program. Class ID wells may also accept wastes that are eligible for injection in Class IID wells.

A Class IID well is a well for injection of materials that are brought to the surface in connection with conventional oil and gas exploration and production. The USEPA has delegated authority for Class IID wells to AOGCC, under the UIC Program.

In the event of well control problems, CPAI will have provisions in place for drilling a relief well or for well capping as required in Alaska Department of Environmental Conservation (ADEC) regulation 18 AAC 75.445(d)(2). Specialized personnel and the equipment needed for well control are available on the North Slope through mutual agreement and would be able to be mobilized within 24 to 48 hours of notification (CPAI 2003f).

Gravels generated during drilling are washed at the Alpine Field. Washed gravel is tested for heavy metals, diesel, and other hydrocarbons. After testing, the washed gravel is used on pads and roads to compensate for gravel loss from compaction. Each well typically generates about 50 cy of gravel for re-use (ref memo from T Maunder, PE, AOGCC).

Estimated North Slope manpower required for the applicant’s proposed action during the drilling phase is provided in Table 2.3.3-1. This estimate includes labor for all drilling. It has been assumed for the purposes of analysis for the applicant’s proposed production pads that there would be no difference in drilling manpower requirements among the alternatives, except for roadless pads, which would have an additional 15 personnel. The drilling requirements for FFD only can be estimated in broad ranges until specific plans and schedules are developed.

2.3.3.4 Operational Activities at Production Pads

Permanent camp facilities would not be required at any production pads because operations personnel would be based at APF or HPFs. Approximately 100 gpd-per-person of wastewater would be generated during production operations, resulting in an additional 1,000 to 1,500 gpd of wastewater to be disposed of, based on approximately 11 incremental staffing positions estimated for the five proposed pads. Similarly, 1,000 to 1,500 gpd of additional potable water would be necessary. The additional wastewater and fresh water would be generated at and disposed of through APF-1, or for FFD through APF-1 and the new HPFs.

Operations personnel would visit production pads as dictated by the activity level, spill prevention requirements, and access. Manpower requirements for operations at each of CPAI's five proposed production pads are presented in Table 2.3.3-2. For pad access by gravel roads, personnel would make up to two round trips per day (one per 12-hour shift) to each production pad. Operation and maintenance of roadless production pads would be performed remotely from processing facilities, with operators visiting the production pad by aircraft, ice road, or other approved surface transport approximately three times per week (CPAI 2003a). It has been assumed for the purposes of analysis for the five production pads that there would be no difference in operations manpower requirements for the ASDP alternatives, except for roadless pads for which two people would travel together for safety reasons. Manpower requirements for FFD would be comparable on a per-production pad basis, with total manpower levels dependent on the schedule for development.

In addition to the facilities listed in Section 2.3.3.1, the following equipment would be located at a roadless production pad during operations:

- Pickup truck
- Hot oil truck
- Front-end loader
- Tioga heaters (two or three)
- Upright work tanks(s)
- Supersucker or vacuum truck
- Slickline unit
- Portable air compressor
- Bleed tank

Warm and cold storage sheltersRoadless sites would have remote freeze protection of surface piping and well bores, remote monitoring of well annuli, and more extensive use of visual, infrared, gas detection, or camera surveillance than roaded sites.

TABLE 2.3.3-2 OPERATIONS MANPOWER REQUIREMENTS

Estimated Startup Date	**Jun. 2006**	**Oct. 2006**	**Nov. 2008**	**Jan. 2010**	**Nov. 2010**
Field Personnel	**CD-3**	**CD-4**	**CD-6**	**CD-5**	**CD-7**
CPAI Operator	0.50	0.25	1.00	0.25	0.25
CPAI Maintenance	0.50	0.10	1.00	0.10	0.10
Contract Operator	0.50	0.25	0.00	0.25	0.25
Contract Maintenance	0.50	0.10	0.00	0.10	0.10
Heavy Equipment Operator	0.40	0.25	2.50	0.10	0.10
Heavy Equipment/Vehicle Repair	0.20	0.10	1.00	0.00	0.10
Incremental Number of 12-hour positions per production pad	2.60	1.10	5.50	0.80	0.90
Cumulative Number of 12-hour positions per production pad	2.60	3.70	9.20	10.00	10.90

Source: CPAI 2003k

Notes: Each 12-hour position represents two people and is equivalent to 4,380 man-hours per year.

This manpower estimate assumes that a road connects CD-1 to all production pads except CD-3.

The manpower forecast is an estimate of the number of 12-hour positions (that is, two people per position) that would work onsite at the five proposed production pad locations. An estimate of additional personnel necessary at CD-1 to support the five new production pads includes the equivalent of three positions: one additional facility startup supervisor/lead, one additional plant board operator position, one half of an additional contract spill technician position, and one half of an additional contract operations and maintenance position.

The applicant would prepare an SPCC Plan. The SPCC Plan would identify locations and capacities of bulk storage tanks, spill prevention measures, training, inspection and record-keeping requirements, spill response equipment locations, and spill response procedures.

Operation and maintenance responsibilities would include monitoring of the wells, pumping, metering units, monitoring of the pipelines, potential initial spill response, snow removal, and routine operation and maintenance. For remote roadless production pads, all maintenance activities that need ice road support and that are not essential to maintain a safe and environmentally sound operation would be deferred until an ice road is available. Warehousing and repair shops would be located at CD-1 (CPAI 2003a). Cleared snow would be placed in designated areas to minimize ponding during the summer melting period.

Primary electrical power to production pads would be provided by the main power generation facility at APF-1, a generator at CD-6, and power generation at new HPFs. Facility upgrades would be required at CD-1 to provide power to the production pads of the ASDP alternatives. Communications systems between the production pads and processing facilities would include fiber-optic cable and hand-held radio systems. The fiber-optic cable would be supported in cable trays on the new pipeline VSMs or buried in gravel roads (CPAI 2003a; CPAI 2003c). Production pad radio towers to support radio communications are listed in Section 2.3.3.1.

2.3.3.5 Production Pad Abandonment and Rehabilitation

As noted in Section 2.3.1.4, removal of facilities and rehabilitation of the land is the responsibility of the permittee and approval of the plan for removal and rehabilitation is within the discretion of the AO. All costs are the responsibility of the lessee. It is assumed that aboveground facilities would be removed and wells plugged and capped. Equipment could be retrofitted for other North Slope use, or removed from the North Slope for subsequent re-use or scrap. Just as with roads, the ultimate fate of the gravel pad would not be known until closer to the end of the production pad life. Permitting agencies may require that gravel be removed, in part or total, and the tundra be revegetated or, if other uses are determined by the permitting agencies to be preferable, the agencies may allow the permittee to leave the gravel pads in place, revegetated or not revegetated. Removed gravel either would be disposed of or reused for another development.

2.3.4 Oil Spill Prevention, Detection and Response Monitoring, and Surveillance of Pipeline Condition

The uninsulated products line and associated saddle-style pipe supports would be inspected periodically for external corrosion. Internal monitoring for corrosion of pipelines is accomplished by periodic use of an in-line inspection tool called a “smart pig.” The smart pig is an instrumented device that is transported through the pipe with a slug of liquid and records the pipeline wall thickness and changes in pipeline alignment with on-board instruments. Deviations in successive readings would indicate corrosion, broken welds, or pipeline movement, which would trigger closer inspection and possibly repair of the affected section of pipe. Smart pig technology is applicable to pipeline 8 inches in diameter or larger. The seawater, sales oil lines, and MI lines of sufficient diameter would be instrument-pigged on a 5-year interval to verify the effectiveness of the corrosion control programs. Inspection intervals by pipeline type are shown below in Table 2.3.4-1.

Cleaning pigs are non-instrumented devices that are periodically sent through a pipeline to clean and remove wax, scale, and debris. This type of pig would be used for maintenance of the three-phase produced fluid, products, and water injection pipelines. The gas and MI pipelines would not be cleaned by maintenance pigs. To enhance visual monitoring for leak detection, the product line would have dye added to diesel and other products when practical and as determined by operations personnel (CPAI 2003f). In addition, the product line would be monitored for any pressure loss during each transfer procedure.

TABLE 2.3.4-1 PIPELINE MONITORING AND SURVEILLANCE

Pipeline	Type of Surveillance or Monitoring	Frequency	Regulatory Requirement
Three-Phase infield (produced fluids)	Surveillance (No Road = Aerial, Road = Ground Based)	Routine (at least monthly during operations)	NA
	Maintenance pigging	As needed	NA
	Mainline Valve Inspections	Twice per year	NA
	Relief Valves	Annually	NA
Seawater	Surveillance (No Road = Aerial, Road = Ground Based)	Weekly	ROW Lease*
	Surveillance (Ground Based)	Annually	ROW Lease*
	Mainline Valve Inspections	Twice per year	ROW Lease*
	Relief Valves	Annually	ROW Lease*
	Corrosion coupons	Twice per year	ROW Lease*
(If pipeline buried)	Rectifiers	Six times per year	ROW Lease*
(If pipeline buried)	Cathodic protection survey	Annually	ROW Lease*
	Corrosion pigging	Once every 5 years	ROW Lease*
	Maintenance pigging	Monthly	ROW Lease*
	CPM leak detection: application	Once every 5 years	ROW Lease*
	CPM leak detection: temperature transmitters	Annually	ROW Lease*
	Telecommunication Systems	Annually	ROW Lease*
Miscible Injectant	Surveillance (No Road = Aerial, Road = Ground Based)	Routine (at least monthly during operations)	NA
	Pressure loss monitoring	Routinely	NA
	Mainline Valve Inspections	Twice per year	NA
	Relief Valves	Annually	NA
(If over 8-inch in diameter)	Instrumented pigging	Once every 5 years	NA
Products	Surveillance (Aerial)	Weekly	ROW Lease*
	Surveillance (Ground Based)	Annually	ROW Lease*
	Mainline Valve Inspections	Twice per year	ROW Lease*
	Relief Valves	Annually	ROW Lease*
	Corrosion coupons	Twice per year	ROW Lease*
(If pipeline buried)	Rectifiers	Six times per year	ROW Lease*
(If pipeline buried)	Cathodic protection survey	Annually	ROW Lease*
	Maintenance pigging	Quarterly	ROW Lease*

TABLE 2.3.4-1 PIPELINE MONITORING AND SURVEILLANCE (CONT'D)

Pipeline	Type of Surveillance or Monitoring	Frequency	Regulatory Requirement
	CPM leak detection: application	Once every 5 years	ROW Lease*
	CPM leak detection: temperature transmitters	Annually	ROW Lease*
	Telecommunication Systems	Annually	ROW Lease*
	Pressure loss monitoring	Each transfer	NA
Sales oil	Surveillance (Aerial)	Weekly 49 CFR 412: 26 times per year	18 AAC 75.055(a)(3) 49 CFR 195.412
	Surveillance (Ground Based)	Annually	ROW Lease*
	Mainline Valve Inspections	Twice per year	49 CFR 195.420
	Relief Valves	Annually	49 CFR 195.428
	Corrosion coupons	Twice per year	49 CFR 195.579(b)
(If pipeline buried)	Rectifiers	Six times per year	49 CFR 195.573(c)
(If pipeline buried)	Cathodic protection survey	Annually	49 CFR 195.573(a)
	Corrosion pigging	49 CFR 195.579(a) Once every 5 years (operator defined) 49 CFR 195.452(j)(3): Once every 5 years	49 CFR 579(a) 49 CFR 195.452(j)(3) (Integrity Management Program Covered Sections Only)
	Maintenance pigging	Monthly (operator defined)	49 CFR 579(a)
	CPM leak detection: application	Once every 5 years	49 CFR 195.444
	CPM leak detection: temperature transmitters	Annually (operator defined)	49 CFR 195.444
	Telecommunication Systems	Annually (operator defined)	49 CFR 195.408

Notes:
ROW Lease could be a Unit Plan of Operation Approval or Spill Plan and Prevention Approval in some cases.

For the seawater line and sales oil line in the FFD scenario, internal corrosion would be monitored by use of corrosion coupons that determine corrosion rates based on weight loss. Two corrosion coupon stations would be located in each segment of the USDOT-regulated sales line: one upstream of the pig launcher and one downstream of the pig receiver. Air and ground inspections of the sales oil pipelines in the FFD scenario would be conducted at least monthly. The goal of these aerial surveys would be visual detection of oil leaks that may develop as a result of a leak below the monitoring threshold of the leak detection system. Twin Otter flights also would be equipped with a Forward-Looking Infrared Radar (FLIR) system for use periodically in conjunction with the weekly aerial surveillance. The FLIR system is capable of detecting small temperature differences that result if a leak occurs (CPAI 2003f).

2.3.4.1 Spill Prevention

The information presented here summarizes the equipment and operational procedures and requirements included in the applicant's proposed action. The spill prevention, detection, and response plans for facilities included in FFD would be similar in nature. The Alpine Oil Discharge Prevention and Contingency Plan (ODPCP) would be revised to address spill prevention measures, potential spills, and capability to meet spill response planning standards at the satellite locations.

CPAI would provide training to its employees on the importance of avoiding oil or hazardous material spills and on spill response. CPAI would also provide new-employee orientation, annual environmental training seminars, and appropriate certification classes. Safety meetings would be held on a regular basis, and would include training for spill prevention and response. An Incident Management Team also would participate in scheduled training programs and would conduct spill response drills. These training programs are regularly conducted at the Alpine Development Project, and the ASDP personnel would receive training through that established program (CPAI 2003a).

Actuated block valves would be installed on each end of some pipeline segments to control flow (CPAI 2003g). CPAI proposes to install a block valve on the produced fluids pipeline at CD-3 and one at CD-1, to allow isolation of the pipeline across lower Colville River Delta channels. These valves would be shut manually or by remote control. Workers could reach manually controlled valves by use of a helicopter, all-terrain vehicle, low-ground-pressure vehicle, snowmobile, boat, etc. (CPAI 2003a). The BLM approval of an exception to Stipulation 24(i) in the Northeast National Petroleum Reserve-Alaska IAP/EIS would be required for emergency tundra travel to allow tundra access during a spill response in the summer. CPAI has committed to designing pipeline valve placement in accordance with ASME B31.4 (2002) Section 434.15 (CPAI 2003g). ASME B31.4 Clause 434.15.2 calls for a mainline block valve on the upstream side of a major river crossing and either a block or check valve on the downstream side of a major river crossing. CPAI proposes to install valves in the produced fluids pipeline on both sides of the Nigliq Channel and on both sides of the Ublutuoch River. Spill containment equipment would be installed below each isolation valve.

2.3.4.2 Spill Response Resources

Oil spill responders would be able to reach production pads by several means. Primary spill responders would come from CD-1 and from Alaska Clean Seas (ACS), with additional resources available from the Kuparuk Oilfield, the Nuiqsut Village Response Team, and mutual aid providers (CPAI 2003a). Some response equipment also would be staged at the production pads and at key control points on or adjacent to river or stream pipeline crossings. ACS has pre-staged equipment in containers by the Nigliq Channel crossing. Where applicable, the existing response vessels staged at CD-1 would be utilized, including shallow-draft response workboats and airboats. To expedite response to a spill event in the Delta, CPAI proposes two additional river access points. A gangway to a floating dock at CD-3 would access the East Ulamnigiaq Channel. The Nigliq Channel would be accessed by a boat ramp to be located at CD-4. The CD-3 gangway and dock would be used for launching small aluminum skiffs and airboats for rapid deployment of personnel and spill response equipment such as booms, skimmers, and pumps. The ramp at CD-4 would be designed to launch a 12,000-pound freighter, twin-engine airboat, a boat that is larger than existing boats in the spill response fleet of the Alpine Development Project. Response workboats and airboats typically would be able to access larger river channels within a few hours, depending on the location and channel characteristics. Low-ground-pressure vehicles for tundra travel such as Rolligons or Tuckers generally would have access to the production pads from CD-1, except during high water when conditions are not safe for their use. The state allows the use of low-ground-pressure vehicles on its lands on a case-by-case basis from July 15 to the following break-up, and additional vehicles are allowed to respond to catastrophic oil spills. The BLM does not allow vehicle access to its lands until specific frost and snow conditions have been met, but could grant exceptions to address a spill.

Specialized personnel and equipment (capping stack, cutting tools, etc.) would be available for response to a well blowout at a satellite production pad location within 24 to 48 hours.

Cross-tundra travel using Rolligons, Tuckers, or other approved tundra travel vehicles would be slow because these low-ground-pressure vehicles are designed to travel at a speed of only 6 to 12 miles per hour (mph) (ABR, Inc. 2003; RTSC 2000). Motorized vehicles from CD-1 would have access to the production pads when ice roads are serviceable (historically from January to early May) and year-round for those production pads with gravel road access. Helicopters and small cargo aircraft would have year-round access to production pads with airstrips when visibility permits.

2.3.4.3 Spill Detection Methods

The primary methods for leak detection would be pipeline pressure/flow monitoring and visual inspection. Three-phase produced fluids pipelines would contain low-pressure switches that automatically shut in the pipelines upon detection of a significant leak or line rupture (CPAI 2003h). Monitoring for small leaks would be accomplished primarily by visual inspection during routine visits to production pads. Additionally, all pipelines would be visually inspected on a regular schedule by (1) aircraft overflight observations; (2) use of the FLIR monitoring system operated from aircraft (such as a Twin Otter); or (3) ground observations from vehicles traveling on an access road (CPAI 2003a).

2.3.5 Gravel Sources

Gravel for building roads and pads would be mined from one of several potential source locations. Two locations already identified are the existing ASRC Mine Site and Clover (see Figure 2.2.3-1). The ASRC Mine Site is approximately 6 miles southeast of the proposed CD-4 facilities. Clover is on the distal western edge of the Colville River Delta, approximately 10.8 miles southwest of CD-1 and 7.4 miles southwest of the proposed CD-4 (CPAI 2002). The ASRC Mine Site already is permitted, Clover would require a separate permit and reclamation plan (see Appendix O).

The existing ASRC Mine Site would be utilized as a source of gravel fill material for proposed roads, pads, and airstrips in the eastern portion of the Plan Area. For Alternative A, approximately 27 acres within the existing ASRC Mine Site would yield approximately 836,000 cy of gravel for use in the ASDP. Use of the ASRC Mine Site for the ASPD would be within the existing capacity as permitted by the USACE and State of Alaska. Accordingly, analysis of the impacts of the proposed use of the ASRC Mine Site as a gravel source for the ASDP are not described in detail in this EIS document.

Nuiqsut contractors received Permit No. 4-960869 for the ASRC Mine Site from the USACE on June 23, 1997, authorizing a 10-year phased development of a consolidated sand and gravel site involving excavation of up to 5 million cy of sand and gravel. Phase 1 includes approximately 1.5 million cy from a 32-acre area. Additional authorized phases to meet future sand and gravel needs in the area include approximately 3.5 million cy from 80 acres. The total permitted footprint for the ASRC Mine Site is 150 acres. A site-specific mine reclamation plan is included in the permits. Successful execution of the reclamation plan is required by permit conditions. The USACE completed a Permit Evaluation and Decision Document that included an EA, and reached a Finding of No Significant Impact. A final Coastal Zone Management Consistency Determination was issued March 5, 1997, by the Office of the Governor of Alaska.

Estimates indicate that the ASRC Mine Site has sufficient gravel for road and pad construction associated with CD-3 and CD-4, and Clover would provide gravel for road and pad construction associated with CD-5, CD-6, and CD-7. Additional gravel sources probably would be needed for FFD. Any new gravel source would require a separate permit and reclamation plan. The impacts to physical resources from developing future gravel sources could be similar to those associated with developing Clover if in similar habitat. The impacts to biological resources would depend on what biological resources make use of the specific area in which gravel is identified. Analysis of those impacts and appropriate mitigation would be examined before approval of use of such future sites.

The development process for Clover or any future gravel source would include planning, designing, temporary staging areas, removal of overburden, blasting and excavation of gravel, and rehabilitation of the site (see

Appendix O). Rehabilitation would consist of regrading and landform construction, water recharging, and revegetation. If the mine site is within a floodplain, the rehabilitation plan also could address creation of fish habitat areas.

The use of gravel source sites would require developing and transporting the gravel by ice roads and pads. A detailed geotechnical analysis of the fill material would delineate areas of different material size and moisture content and quality. Fill would be segregated at the time of mining, and the higher-grade material would be reserved for the CD-1 to CD-4 road lake crossing (Lake L9323) or as topping material.

Excavation would occur during winter months to support winter road and pad construction. Blasting would be required to mine gravel, regardless of season, because all but the surface layers are permafrost. An ice bridge would be required if gravel would be transported over the Colville River Delta from the ASRC Mine Site (Figure 2.2.3-1). Equipment required to mine the large quantities of gravel needed for the applicant's proposed action would typically include the large bulldozers, excavators and/or loaders, hauling trucks, drill rig/compressor, and road grader.

Overburden materials would have to be stockpiled. The ASRC Mine Site overburden is approximately 22 feet deep at run (TMA 2000). Stockpile areas may consist of ice pads constructed adjacent to the gravel pit, with the pad size depending on the depth of overburden soils and the volume of underlying gravel to be extracted. For example, overburden soils removed from the ASRC Mine Site during previous operations required 1 acre of stockpile area (on an ice pad) for every 25,000 cy of overburden (TMA 2000).

Blasting holes typically are made with a pneumatic drill/compressor arrangement that may operate continuously during drilling. After blasting with dynamite, trucks would transport the gravel on ice roads to the road or pad construction locations where it would be placed.

Closure of a gravel mine site would occur after the supply of gravel is exhausted, or operation is no longer economical. Upon closure of mining cells, the overburden material would be placed back into the gravel pit, and landforms as required by permit stipulations would be constructed. To illustrate, landforms required during development of Phase 1 of the ASRC Mine Site included shallow littoral zones, very shallow littoral zones, waterfowl nesting islands within the nesting lake, and artificial revegetation (TMA 2000). New surface water bodies created by the mine pit impoundments would be left to recharge naturally through a stream or man-made channel during annual spring break-up floods. This process could be aided by placement of upwind soil berms to accumulate windblown snow in the water impoundments.

2.3.6 Airstrips

To allow year-round access during drilling and operation phases, gravel airstrips would be constructed at roadless production pads, isolated groups of interconnected pads, and in the FFD scenario, the new HPFs. Airstrips would be constructed in the same manner as gravel roads, typically offset slightly from the main pad but connected with a short access road. Gravel airstrips would be at least 5 feet thick and would have slideslopes of at least 2H:1V (CPAI permit application). Potential for erosion would be evaluated for each airstrip, and if necessary, slideslope protection measures would be designed. For impact analysis, tundra coverage and gravel quantities are estimated by using a 5-foot average thickness. All airstrip quantities and acres covered are calculated by using a 2H:1V slideslope. Airstrips as proposed by CPAI and as anticipated for FFD would be oriented so that the runways would be aligned with the prevailing northeast winter winds to minimize snow drifting. No hangars or aircraft refueling facilities would be available at the individual production pads. Dimensions of airstrips at production pads would be sized appropriately for the particular aircraft that would be used. Dimensions would range from a short airstrip of 3,400 feet by 100 feet used by CASA or Otter aircraft to a long airstrip approximately 5,000 feet by 100 feet used by DC-6 and C-130 Hercules (CPAI 2003i). General knowledge of aviation industry practices indicates that the proposed airstrip dimensions would be adequate to serve fully loaded aircraft safely (Stout 2003). Shorter airstrips could be constructed at some roadless production pads, but drilling would be limited to the winter season because airlifting well control equipment during the non-ice road season may not be possible with shorter airstrips

(CPAI 2003a). For the purposes of analysis in this EIS, the working surface of all airstrips is assumed to be 5,000 feet long by 100 feet wide. In addition there would be a safety area approximately 25 feet wide along each side of any runway, 60-foot-wide taxiways and 18-foot-wide runway access roads. All these gravel features would be a minimum of 5 feet thick (CPAI permit application).

For the applicant's proposed action, airstrip construction would occur during the winter. Construction access would be by ice road. Once construction is complete, the estimated flight frequency to production pad airstrips would be two fixed-wing aircraft (usually CASA or Twin Otter) flights every 2 to 3 days. In the case of helicopter-supported production pads, the same frequency would apply for the helicopters.

For CPAI projects, during a 1-year construction season, there would be approximately 700 landings by small aircraft (e.g., CASA or Twin Otter) for personnel, 250 landings for cargo aircraft (e.g., DC-6), and 20 landings by C-130 Hercules aircraft. Air traffic estimates for construction of APF-1 were higher. This EIS includes analysis of air traffic impacts associated with new HPFs based on history at APF-1 (see Figure 2.3.6-1). Heaviest traffic would occur during construction. After the completion of construction and the start of drilling and production, the number of flights would decline. Once drilling has ceased, air traffic at a new HPF might decline; however, it might remain unchanged if the HPF is used to support drilling hypothetical nearby production pads.

The anticipated flight path for the airstrip at CD-3 would be over land areas in the Coleville River Deltas. Flight elevations of less than 1,000 ft would be confined to areas within 3.6 miles northeast and southwest of the airstrip. Flight paths to other airstrips in the FFD scenario would depend on prevailing winds but would generally align with the orientation of the airstrips.

As noted in Section 2.3.1.4, removal of facilities and rehabilitation of the land is the responsibility of the permittee, and approval of the plan for removal and rehabilitation is within the discretion of the AO. Abandonment of airstrips could occur in conjunction with abandonment of pads. The gravel airstrips would be managed in a similar manner, depending on the decisions made by land managers and permitting agencies at the time of abandonment. Gravel airstrips would be (1) removed and the tundra revegetated, (2) revegetated but otherwise left in place, or (3) left in place and maintained for public use.

Unscheduled helicopter traffic, overwhelmingly in summer, would likely occur. It is not part of the applicant's proposed action, though. Rather, this traffic would largely be associated with scientific studies and monitoring of development. The frequency of this traffic and the areas in which it would take place are unpredictable.

2.3.7 Off-Road Travel

2.3.7.1 Ice Roads

Construction of roads could take place throughout the winter season, with road building later in the season being more efficient because of generally colder temperatures, which reduces the time required between water applications. Construction of ice roads would begin in early winter, as soon as tundra travel restrictions are lifted. Current criteria allow ice road construction to begin after the seasonal frost in the tundra and underlying mineral soils has reached a depth of 12 inches of hard frozen ground and the average snow cover is 6 inches of snow (ADNR 2003; BLM and MMS 1998b).

Construction of ice roads begins by compacting snow with wheeled front-end loaders and water trucks. If pre-packing is authorized, it is done with low-ground-pressure vehicles, commonly Rolligons, or various tracked rigs. An initial thin lift of ice aggregate is placed, if available, and water is applied to the snow and/or ice aggregate by water trucks. In conducting this work, machine operators would avoid clipping tussocks or the edges of low-centered polygons and would avoid shrub areas where possible. Upon complete freezing, successive lifts would be sprayed on the surface to a minimum depth of 6 inches, or until polygon ridges or tussocks are completely covered. Ice roads over land typically use approximately 1 million gallons of water per mile of constructed road (PAI 2002a). Typical ice road construction rates on the North Slope average approximately 1 mile per day per crew (Nelson 2003). The typical ice road would be 40 feet wide. Proposed ASDP ice roads for 2005 through 2011 are presented in Figures 2.3.7.1-1 through 2.3.7.1-7.

Ice road maintenance is necessary to keep the road from deteriorating and creating unsafe conditions. Typical equipment necessary for maintaining 20 miles of ice road includes at least one motor grader, a loader-mounted snow blower, and a water tanker truck. Increased numbers of each type of equipment would depend on road orientation, weather, and usage volumes. Graders with snow wings and snow blowers would be used to remove snow and keep berms leveled to prevent drifting.

2.3.7.2 Low-Pressure Vehicle Tundra Traffic

Development and operation of oil facilities in the Plan Area may require access across the tundra off pads or gravel or ice roads. Such access could be necessary to respond to spills or other emergencies, conduct pipeline maintenance and repair, facilitate ice road construction, or transport equipment and supplies to a roadless development site. Vehicles would conduct these activities from the nearest production or processing facility pads or gravel or ice roads.

Low-pressure vehicles, such as Rolligons and Tuckers, are used for such activities. These vehicles commonly exert less than 4 pounds per square inch of pressure to the ground. CPAI can obtain approval to use such vehicles on Kuukpik Corporation lands, on a case-by-case basis. CPAI can obtain permits from the state on a case-by-case basis to use such vehicles on state land between July 15 and break-up the following year. In emergency situations, such as a catastrophic oil spill, the state provides that these vehicles can be used in cleanup operations if the cleanup will be expedited and the use of the vehicle will prevent further environmental damage from the spill.

CPAI also can obtain approval from the BLM to use such vehicles on federal lands. Such use would have to comply with Northeast National Petroleum Reserve-Alaska stipulations. The BLM typically allows low-pressure vehicle use after the frost underlying mineral soil has reached a depth of 12 inches and an average snow cover of 6 inches.

Where roads are available, low-pressure vehicles would only traverse short distances. Pipeline repair and spill response likely would entail travel on the road to a place near the repair or spill, before traversing the tundra to reach the pipeline or spill location. If there are no roads, pipeline repair or spill response would require cross-tundra travel by the nearest low-pressure vehicle. Transporting equipment or supplies to a roadless site could entail many miles of tundra travel. This travel most likely would occur during the winter, when state, federal, and/or the NSB governments would put fewer restrictions on travel.

2.3.8 Boat Ramps and River Access

Two river access points are proposed to provide safe and reliable river access for spill response personnel. Two types of river access are proposed. Access to the East Ulamnigiaq Channel via a floating dock and gangway is proposed for CD-3 (see Figure 2.3.8.1-1). Access to the Nigliq Channel via a boat ramp is proposed for CD-4 (see Figure 2.3.8.1-2). Additional boat ramp facilities may be required for spill response under FFD. Design of these facilities would be similar to that of the proposed facilities.

2.3.8.1 Boat Ramp

One boat ramp is proposed for CD-4 (see Figure 2.3.8.1-2). The ramp would be designed to launch a 12,000-pound freighter, twin-engine airboat, a boat that is larger than existing boats in the spill response fleet of the Alpine Development Project. The potential CD-4 location would include a 2,400-foot-long by 22-foot-wide, minimum 4-foot-thick, gravel-access road and a 130-foot-long concrete launch ramp. Upstream and wrap-around surfaces of the gravel access road would receive slope protection.

2.3.8.2 Floating Dock

An 8-foot-wide gangway connecting the shore to a 12-foot by 16-foot floating dock is proposed for CD-3. This gangway and dock would be used for launching small aluminum skiffs for rapid deployment of personnel and spill response equipment such as booms, skimmers, and pumps. The gangway and floating dock would be installed each spring and removed at freeze-up by a front-end loader. Pilings would be installed to support the gangway and to anchor the floating dock. The pilings would be permanent, year-round installations.

2.3.9 Bridges and Culverts

The decision about whether to use culvert(s) or bridge(s) in the proposed action is based on the best technical and economical way to provide drainage at each particular crossing. Considerations include drainage discharge, limiting erosion, crossing footprint, fish passage criteria, constructability issues, ice passage issues, impacts on road design, maintenance, and load limits.

2.3.9.1 Bridge and Culvert Design

BRIDGES

Bridges may be necessary for either vehicle or pipeline crossings of certain water bodies. All planned vehicle-capable bridges would be heavy-duty; i.e., capable of supporting a fully-assembled drill rig.

Pipeline-only bridges carry much-reduced loads, which allows the structure generally to span longer distances, reducing the need for instream piers. CPAI proposes to use a box girder design for any pipeline-only bridge. Figures 2.3.9.1-1 through 2.3.9.1-3 present pipeline bridge crossings for the Sakoonang, Tamayayak, and Ulamnigiaq channels. Figure 2.3.9.1-4 shows a typical pipeline bridge abutment foundation cross-section.

This type of bridge can span 200 to 350 feet (Michael Baker, Jr. 2002c). Box girders are very rigid and can support pipelines from above, beneath, or along the sides.

Vehicle-bridge crossing lengths may be further refined as the existing hydraulic assessment data are augmented by ongoing CPAI studies and data collection. Short crossings typically could be made to clear-span approximately 55 feet without requiring instream supports. CPAI’s vehicle bridge design for short crossings is shown in Figures 2.3.9.1-5, 2.3.9.1-6, and 2.3.9.1-7. Long crossings could span approximately 130 feet between piers. CPAI’s bridge design for long crossings is shown in Figure 2.3.9.1-8. Bridge structural design would account for the higher-magnitude and lower-frequency floods, and ground protection armor would protect against the higher-frequency, lower-magnitude floods.

The road bridges typically would be designed so that structural support consisting of box girders or I-shaped plate girders would be located under the driving surface to accommodate the wide loads common to oil development. They would have 30-foot- (two-lane) wide driving surfaces and removable guardrails, again to accommodate the occasional wide loads. Decking material would be constructed out of pre-cast concrete decking.

The Nigliq Channel bridges would be built with a foundation consisting of a steel pile system with ice-breaking structures designed into the upstream side on each instream pier. An ice-breaking structure would be installed on the upstream side of each instream pier group. Each ice-breaking structure would require three additional pilings (Figure 2.3.9.1-8).

Box girder bridges are most desirable for co-locating pipelines on the vehicle bridges. Pipelines co-located on vehicle bridges would be situated alongside the girders, which would be below the driving surface and would not have an effect on the capability of the bridge to handle wide vehicle loads (Figure 2.3.9.1-8). The pipelines would be installed on the downstream side of the bridge structure in areas where there is potential for ice impacts to pipelines during break-up. An exception could be if a bridge is high enough to avoid any potential ice impacts; the pipelines then could be placed on the upstream side of a bridge structure.

Bridge crossing lengths and other variables necessary for detailed bridge design may be further refined as the existing hydrologic and hydraulic assessment data are augmented by ongoing CPAI studies and data collection.

For general navigability purposes, water level clearance to the lowest point of the superstructure crossing the Nigliq Channel would be 20 feet during normal summer water levels, except for the support piers, which would extend down through the water and below the river bed. Other drainages could have lower clearances, as determined by hydraulic and navigability factors.

Hydrologic constraints are an important consideration when designing bridges. Factors that are considered in the detailed design to protect the integrity of the bridge structure include design water surface elevations and velocities, scour protection, ice impacts and jams, storm surges, and waterway opening requirements. Bridge siting criteria generally include narrow channel, straight reach of stream, hydrological stability, good access from each side, ice jam potential, and direction of flow.

Bridge abutments would be armored. Armoring would consist of pile-supported pier groups, similar to the instream structure, or open-cell sheet pile. To reduce the footprint and prevent scouring of gravel roads leading up to a bridge, sheet-pile wing walls would be driven around bridge abutments.

CULVERTS

Generally, the use of large diameter culverts has not been very successful on the North Slope because of long-term thermal stability issues, difficulty of construction, and load-carrying capacity issues. Therefore, current road construction practice is to utilize available line pipe, usually up to 60 inches in diameter, as culverts in place of corrugated metal pipe types of culverts (see Figures 2.3.9.1-9 and 2.3.9.1-10). The line pipe culvert has more structural strength and has had a much better record of survivability and service. Corrugated metal pipe is preferable for fish passage.

At a discharge of 500 cubic feet per second (cfs), the number and spacing of culverts required to pass the flow and/or ice may not easily fit within the specific channel/floodplain for which it is designed. Therefore, a bridge would be considered when channelized flow occurs with a 50-year recurrence interval flood discharge of 500 cfs or more.

As a standard practice, cross-drainage culverts would be placed under roads approximately every 500 feet. These cross-drainage culverts would be used in addition to culverts or bridges specifically placed in known drainage locations. Cross-drainage culverts would be up to 5 feet in diameter (see Figures 2.3.9.1-10 and 2.3.9.1-11).

2.3.9.2 Bridge and Culvert Construction

BRIDGES

Bridge construction is anticipated to take place during the winter (CPAI 2003a). Ice pads would be constructed at each end of the bridge to stage girders, bridge decking, pilings, and equipment. Large cranes set up on each bank would bore holes for pile installation or would drive the piles. If instream piers were necessary, an ice pad would likely be built adjacent to the bridge site for the crane to work from.

If cuttings were produced from pile installation, those cuttings would be used for backfill around the piles and would be hauled by truck to a road or pad construction site for immediate use or to gravel pits and placed in the waste material area of the pit.

Ice pads for staging areas would vary with the size of the bridge and the equipment needs. However, if all construction materials had to be stored onsite at one time before construction began, such as for the approximately 1,200-foot-long Nigliq Channel bridge, the estimated pad size would be approximately 800 feet by 800 feet and would surround the abutment structure at each end of the bridge.

An entire bridge assembly, particularly the larger bridges, would be too heavy for a typical mobile crane to lift into place. Therefore, components would be fabricated offsite, with assembly taking place in the field. Tractor-trailer trucks would usually transport materials to the site. Assembly and installation would require cranes, loaders outfitted with forks, and various welding and light construction equipment. Depending on the type of bridge, every 100-foot section of bridge would require up to 16 truckload cycles to transport materials to the bridge site (maximum of 40-foot lengths), and each abutment would require 15 truckloads to haul sheet piling.

CULVERTS

Culverts typically would be installed perpendicular to the roadbed to minimize the length of culvert required, unless the drainage channel requires the culvert to be skewed relative to the road alignment. For culverts to allow cross flow and prevent ponding, installation typically would occur after the gravel structure of the roadbed has been constructed. The first step would involve excavating a trench across the roadbed, including a minimum of 2 feet of the thaw-unstable Native soils below the gravel road structure (McDonald G.N. 1994). The average width of the culvert trench is 5 feet (email, S Rothwell, 3-18-04). The Native soils would be replaced by gravel to provide stable bedding for the culvert. Gravel used to backfill around the culvert would consist of the same material utilized in road construction. Culverts placed in streams and flow ways would be constructed in a manner to maintain flow and fish passage.

2.3.9.3 Bridge and Culvert Operations and Abandonment and Rehabilitation

Typical maintenance activities could include removing sediment buildup on structural members, maintaining the corrosion protection system, monitoring the deck surface, replacing or resurfacing the deck system, and monitoring foundations.

As with roads, abandonment of bridges and culverts would occur after the economic life of the oilfields had passed. As noted in Section 2.3.1.4, removal of facilities and rehabilitation of the land is the responsibility of the permittee, and approval of the plan for removal and rehabilitation is within the discretion of the AO. Because the bridges and culverts are an integral portion of the proposed road network, the fate of the bridges would likely be determined by the fate of the road network. Abandonment of gravel roads is discussed in Section 2.3.1.4. If bridges would be removed, bridge superstructures would be taken apart and transported out of the area for recycling or disposal of the materials. Bridge piles likely would be cut off below the lowest anticipated scouring elevation from either natural scouring or a flood-induced event. The area of bridge abutments would be revegetated in a manner similar to that of the roadbed after gravel removal. If roads are left in place but not with the intention that they would be maintained for continued use, culverts may be removed and the gravel pads breached to facilitate water flow.

2.3.10 Traffic

Seasonal air and ground traffic estimates to support the construction, drilling, and operations for the ASDP are presented in Table 2.3.10-1 below. These traffic estimates are pertinent to Alternatives A, B, C-1, C-2, and F. Total traffic for Sub-Alternative C-2 would be split between CD-1 and Nuiqsut after the state-proposed Colville River Road is operational; however, this is not anticipated to occur until late in the construction phase (2010). Traffic for Alternative D is presented separately with the details of Sub-Alternatives D-1 and D-2. These traffic estimates assume all construction travel to production pads is via ice roads or gravel roads. Traffic for FFD would continue at levels proportional to those estimated for the five-pad ASDP. The extent of FFD traffic would be determined by how many of the HPs and HPFs would be proposed. In all cases, speed limits for traffic would be the same as currently enforced at existing North Slope pads and roads: 5 mph on process pads, 15 mph on production pads, and up to 45 mph on roads. Non-operations traffic would likely occur in the area of the applicant's proposed action from a variety of users besides industry, including federal and state agencies, universities, and local residents.

TABLE 2.3.10-1 ASDP – TRAFFIC ESTIMATES

	Construction Phase		Drilling Phase		Operations Phase	
	Round-Trip Vehicle Trips per Month [a]	One-Way Aircraft Flights Per Month [a]	Round-Trip Vehicle Trips per Month	One-Way Aircraft Flights Per Month	Round-Trip Vehicle Trips per Month	One-Way Aircraft Flights Per Month
Winter 2004/2005	6,000 (18,600 max.)	70 (235 max.)	390-450	70-90	0	0
Summer 2005	740 (2300 max.)	180 (500 max.)	0	0	0	0
Winter 2005/2006	5,800 (19,800 max.)	60 (245 max.)	390-450	70-90	0	0
Summer 2006	1,700 (3,100 max.)	340 (615 max.)	390-450	70-90	60-120	8-32
Winter 2006/2007	3,900 (12,000 max.)	70 (165 max.)	390-450	70-90	68-120	8-16
Summer 2007	3,000 (3,000 max.)	45	390-450	70-90	60-120	8-32
Winter 2007/2008	4,000 (11,700 max.)	50 (145 max.)	390-450	70-90	68-120	8-16
Summer 2008	8,000 (8,100 max.)	100 (105 max.)	780-900	70-90	60-120	8-56
Winter 2008/2009	2,800 (7,500 max.)	50 (205 max.)	390-450	70-90	76-180	8-24
Summer 2009	0	0	390-450	70-90	60-180	8-56
Winter 2009/2010	1,000 (3,600 max.)	50	780-900	70-90	76-180	8-24
Summer 2010	6,600 (6,700 max.)	85 (100 max.)	780-900	70-90	60-180	8-80
Winter 2010/2011	600 (3,300 max.)	45	780-900	70-90	84-180	8-32

Source: CPAI 2003l

Notes:

Includes one-way aircraft flights between Kuparuk and Alpine or between Nuiqsut and Alpine.

All production-pad access for construction is either via ice road or gravel road, no construction-related flights to production pads.

Indicated schedule is applicable to Alternatives A, B, C, and F.

Excludes non-operational helicopter flights estimated at 2500 per summer season.

For the purposes of this table, seasons have been defined to correspond to periods when wildlife and bird populations are prevalent in the plan area, i.e., Summer = May through SeptemberNovember and Winter = December October through April. These seasonal designations do not correspond with periods of ice road travel, for which winter would be defined as December through April.

[a] Averages are shown, followed by maximum monthly estimates in parenthesis.

In addition to the traffic indicated in Table 2.3.10-1, non-operations helicopter flights would occur. Activities supported by non-operational helicopter flights may include environmental studies, environmental monitoring, surveys, travel for important people, and agency tours. CPAI reported 1,250 non-operational helicopter flights departing from and 1,250 non-operational helicopter flights returning to the Alpine Development Project for a summer season. Each of those flights could include multiple landings and takeoffs away from the Alpine Development Project, but those intermediate landings and take-offs are not logged. It should be noted that some studies performed during the last 3 years, and presumably included in those numbers, are studies supporting the ASDP. Thus, a best-case scenario could be that ASDP non-operational helicopter flights are ongoing and are included in the CPAI count of non-operational helicopter flights for the existing Alpine Development Project.

For impact analysis, a conservative approach assumes that ASDP non-operational helicopter flights will be equal to the CPAI count of non-operational helicopter flights for the existing Alpine Development Project; that is, 1,250 outgoing and 1,250 returning flights per summer season, with those flights potentially including intermittent landings and take-offs to various locations. The ASDP flights would also be departing from and returning to CD-1, resulting in a total summer season of 5,000 non-operational helicopter flights at CD-1.

2.3.11 Utilities

2.3.11.1 Electric Power Generation

Delivery of electrical power to CD-3 through CD-5 during operations would be provided from APF-1. An additional 2.7 to 3.1 megawatts (MW) of power generation capacity would be provided from CD-6 and would also serve CD-7. Facility upgrades would be required at APF-1 to provide power to the production pads. These upgrades may include additional gas-fired turbo-generation. During construction and drilling, portable generators would provide temporary power, as necessary. There would also be 500-kilowatts (kW), diesel-fired emergency generators provided at CD-3 and CD- 6 in the ASDP, and at all roadless pads in FFD alternatives. Electric power generator sets would be totally enclosed or would be acoustically packaged to abate noise emissions.

2.3.11.2 Electric Power Distribution

CPAI proposes to route power cables in cable trays mounted on VSMs, and to use an overhead powerline between CD-6 and CD-7. Overhead powerlines would be strung on 60-foot poles spaced 250 feet apart. Borings for power pole installation would be 2 feet in diameter and 14 to 17 feet deep (email, S Rothwell, 3-18-04). Other alternatives look at placing all power wires on poles or burying them. Cable trays would be added to VSMs at the same time as the pipelines. Direct burial of the powerline would occur during the winter, installing the powerline into a trench in the gravel roadbed. In areas where trenching into the tundra would be required, the trench would be cut through an ice road, the power cable placed, and the cuttings pushed back into the trench. The typical trench for power cable burial is 10 to 12 inches wide and 4 to 6 feet deep (email, S Rothwell, 3-18-04). A 500 – kilowatt (kW) emergency generator would be located at all pads that are not road accessible.

2.3.11.3 Communications

Communications systems between the production pads and APF-1 and FFD HPFs would include fiber-optic cable and various wireless systems (PAI 2002d). The fiber-optic cable would be strapped to a pipeline or laid in a cable tray as shown in Figure 2.3.2.1-1. Transmission towers up to 200-feet-high would support radio communications for the processing facility.

2.3.11.4 Fresh Water

Fresh water would be required for ice road construction; potable water use to support construction, drilling, and operating camps; and drilling and drilling mud use. Fresh water or seawater could be used for hydrostatic testing. Estimated water demand for fresh water for ice road and ice pad construction is presented in the discussion of each alternative. Potable water requirements are based on a demand of 100 gpd per person, and the construction, drilling, and operations manpower estimates presented above. Drilling water requirements are estimated to be 38,000 gpd. Fresh water would be taken from approved surface water sources.

2.3.11.5 Wastewater

Discharges to surface water would occur in compliance with the NPDES Permit for Oil and Gas Extraction on the North Slope of the Brooks Range, Permit Number AKG-33-0000, or an Individual NPDES Permit. The NPDES permit covers gravel pit dewatering, storm water, hydrostatic test water, and domestic wastewater from temporary camps. Wastewater sources, quantities, and disposition are comparable for each alternative.

The USEPA is a cooperating agency for the ASDP EIS because of its NEPA compliance responsibilities for issuing an NPDES permit under Section 402 of the CWA. Discharges associated with oil and gas facilities are subject to effluent limitations and are considered new sources; therefore, a NEPA evaluation is required before issuance of an NPDES permit (40 CFR §122).

The USEPA General NPDES Permit may be used to authorize new source discharges specified in the General Permit. However, the USEPA may determine that an Individual NPDES Permit may be required if the discharge fails to meet the applicability requirement or if certain conditions exist as indicated in Section 1.F of the General Permit. This determination may require additional NEPA compliance that is tiered from this EIS.

The USEPA expects that the General Permit or any Individual Permit developed would have similar limitations. Domestic wastewater discharges associated with the General NPDES permit would be limited and monitored according to the effluent limitations presented in Table 2.3.11-1. However, applicants for either a General Permit or an Individual Permit may apply to the ADEC for a mixing zone for fecal, chlorine, and dissolved oxygen. For a General Permit, the mixing zone would be subject to public notice prior to permit coverage being authorized. For an Individual Permit, the mixing zone would be included in the ADEC's water quality certification of the permit. It is expected that the requirements would be the same under either permitting alternative.

TABLE 2.3.11-1 DOMESTIC WASTEWATER EFFLUENT LIMITATIONS

Parameter (units)		Daily Minimum	7-day Average	30-day Average	Daily Maximum
Flow, gpd		—	—	—	25,000
Biochemical Oxygen Demand (BOD5), mg/L		—	45	30	60
Total Suspended Solids (TSS), mg/L		—	45	30	60
Loading limits for BOD and TSS will be calculated based on design flow.					
Fecal Coliform, # colonies/100 mL	Freshwater	—	—	20	40
	Marine	—	—	14	43
Dissolved Oxygen, mg/L	Freshwater	7.0	—	—	—
	Marine	6.0	—	—	—
Total Residual Chlorine (TRC), ug/L	Salmonid stream	—	—	—	2
	Non-salmonid stream	—	—	—	10
pH, standard units		6.5	—	—	8.5

Notes:

The discharge shall not, alone or in combination with other substances, cause a film, sheen or discoloration on the surface of the receiving water or adjoining shorelines.

No discharge of floating solids, foam or garbage.

Kitchen oils from food preparation shall not be discharged.

A Best Management Practices (BMP) Plan is required by the permittee.

Wastewater discharges associated with temporary drilling camps would be limited to domestic wastewater (both graywater and sanitary waste). Discharges would be sporadic, varying in quantity with the time of day. Average daily temporary camp water and wastewater flow would be approximately 100 gpd per person, or 10,000 gpd. The maximum flow discharge would normally occur any time from later afternoon until midnight each day. This maximum flow rate would be limited to 25,000 gpd of combined sanitary and graywater. Receiving waters would be frozen tundra during winter months and thawed tundra (wetlands) or streams during the nonfrozen season. The major streams closest to each production pad are identified in Table 2.3.11-2.

TABLE 2.3.11-2 PROXIMITY OF PRODUCTION PADS AND PROCESSING FACILITIES TO MAJOR RIVERS AND STREAMS

Facility	Nearest Major Stream	Approximate Distance (miles)
CD-3	Tamayayak Channel	<0.1
CD-4	Nigliq Channel	<0.5
CD-5	Nigliq Channel	2.0
CD-6	Fish Creek	2.0
CD-7	Judy Creek	3.0
HP-1	Fish Creek	<0.5
HP-2	Judy Creek	2.0
HP-3	Fish Creek	<0.5
HP-4	Colville River	1.5
HP-5	Sakoonang Channel	1.0
HP-6	Ublutuoch River	2.0
HP-7	Tamayayak Channel	<1.0
HP-8	Nigliq Channel	<1.0
HP-9	Colville River	3.0
HP-10	Ublutuoch River	2.0
HP-11	Colville River	1.5
HP-12	Kupigruak Channel	<0.5
HP-13	Elaktoveach Channel	<1.0
HP-14	Colville River	<0.5
HP-15	Tingmeachsiovik	<0.5
HP-16	Judy Creek	1.0
HP-17	Judy Creek	1.5
HP-18	Fish Creek	3.0
HP-19	Judy Creek	2.0
HP-20	Kalikpik River	<0.5
HP-21	Kogru River	4.0
HP-22	Kogru River	<0.5
HPF-1	Judy Creek	<1.0
HPF-2	Kalikpik River	2.0

Wastewater would be treated and discharged in compliance with the NPDES Permit. Sludge either would be incinerated on site or hauled to other operating fields and incinerated. The ash would be transported to the NSB landfill.

Hydrostatic testing would be performed throughout construction. If fresh water is used, it would be tested for contaminants after hydrostatic testing is completed, and then would be discharged onto the tundra through a filter medium to remove any solids. The tundra would be protected so that erosion would not occur during the discharge. The water would be discharged in accordance with the permit requirements. If seawater is used, it could be injected into the reservoir to maintain reservoir pressure or disposed of in a disposal well.

On rare occasions, pipeline hydrostatic tests could be conducted in the winter. In this case, freeze-protected water would be used. The options would be salt brine, glycol/water, or methanol/water solution. At the end of the test, the test fluid could be re-used for another purpose, injected for pressure maintenance, or disposed of in an injection well.

Approximately 100 gpd per person of domestic wastewater would be generated during production operations. This volume would result in an additional 1,000 to 1,500 gpd of wastewater to be disposed of, based on approximately 11 incremental staffing positions estimated for the five proposed pads. The additional wastewater and fresh water would be generated at and disposed of through APF-1, or for FFD, through APF-1 and the HPFs. At the existing APF, domestic wastewater is treated and then disposed of by injection. Solids are filtered prior to the injection. The residual solids are incinerated. The treated camp effluent could be injected into the Class ID well or mixed with seawater and injected into the oil reservoir formation by a Class IID well for enhanced oil recovery (PAI and BP Exploration [Alaska] [BPXA] 2002). Existing Class ID well WD-2 can receive non-hazardous and RCRA-exempt fluids.[2]

No new Class IID wells at any ASDP production pad is proposed. The Class IID well CD1-19A at the existing Alpine Development Project is permitted for disposal of produced fluids, drill cuttings, and other materials that originate below ground; drilling muds and other products that are circulated or used in a well system; or products that come into contact with downhole materials in the course of the production process (PAI and BPXA 2002).

The FFD would include both a Class ID and a Class IID well at each HPF (HPF-1 and HPF-2), and could include additional Class ID and/or Class IID wells at HPs. Because the number and location of additional Class ID and/or Class IID wells is unknown, the potential impacts from locating a Class I or Class II injection well at each HP are considered in this document.

2.3.11.6 Solid Waste

Drilling and operations could generate oily gravel and soil, and would generate food wastes, sewage sludge, and other non-hazardous burnable and non-burnable wastes. Oily gravel and soil would be tested, and depending on test results could be re-used or disposed of. Non-hazardous burnable wastes would be transported to CD-1 and incinerated at the existing Alpine Development Project incinerator in accordance with procedures in *Alaska Waste Disposal and Reuse Guide* (PAI and BPXA 2002). Residual solid waste that cannot be incinerated would be transported to the existing landfill at Deadhorse. The NSB operates that landfill.

2.3.12 Processing Facilities

The five production pads proposed by CPAI, and several of the production pads included in the FFD scenarios, would be connected to the existing APF-1. In addition, two new HPFs similar to APF-1 are considered in the FFD alternatives, HPF-1 and HPF-2. It is anticipated that, similar to APF-1, the pads supporting the HPFs would host production wells. The HPFs for the FFD scenario would be designed, built, and operated in a manner analogous to that used for the existing APF-1.

2.3.12.1 Existing Alpine Processing Facility

The existing Alpine Development Project includes the CD-1 and CD-2 pads, the 5,000-foot-long airstrip (CPAI 2002b), and the interconnecting road from the airstrip to CD-2. Total area permitted by the USACE to be covered by gravel is 112.3 acres. This area includes approximately 36.3 acres for the CD-1 pad and 10.1 acres for the CD-2 pad. APF-1 is at CD-1 and includes a crude oil processing plant, housing for employees, maintenance facilities, a production pad, and a drill equipment storage area. Figure 2.3.12.1-1 presents a plot plan of the existing APF-1.

2.3.12.2 Alpine Capacity Expansion

CPAI plans to upgrade APF-1. These upgrades would require modification to existing processing facilities and construction and eventual mobilization of new facilities to CD-1. Some of the upgrades would support the proposed ASDP; some upgrades would be independent of the ASDP.

---

[2] Class I (non-hazardous wells) can accept non-hazardous wastes, sanitary and domestic wastewater, and RCRA-exempt wastes (40 CFR 144.6). Note that there are a total of seven Class I non-hazardous waste wells on the North Slope. Class I (hazardous) wells can accept hazardous wastes. Note that no Class I hazardous well exists on the North Slope. Class II wells are designated for oil and gas production wastes that are brought to the surface from downhole sources. However, fluids that are not from down hole sources can be commingled with wastewater or storm water and injected in a Class II well for enhanced oil and gas recovery.

The upgrades that are independent of the ASDP include Alpine Capacity Expansion (ACX) Projects 1 and 2. The first phase, ACX Project 1 (ACX1), planned for construction to begin in 2004, would increase APF-1 produced-water handling capacity. ACX Project 2 (ACX2), expected to be constructed during 2004 and 2005, would increase the oil train and water injection capacity for the existing Alpine Field. ACX1 and ACX2 are unrelated to the proposed satellite developments and are therefore not considered as part of the ASDP analyzed in this EIS (CPAI 2003j); however, the activities involved with ACX1 and ACX2 are considered in the analysis of reasonably foreseeable cumulative impacts.

ACX Project 3 (ACX3) includes an expansion of gas-handling capacity that is necessary to handle production at CD-7. The gas expansion component of ACX3 is planned for offsite construction of modules in 2008 and sea lift to the North Slope in 2009. It would increase gas-handling capacity from 180 million standard cubic feet per day (mmscfd) to 270 mmscfd or up to 360 mmscfd. Timing of these expansions is presented below in Table 2.3.12-1 along with the proposed drill site production schedule. Because the gas expansion portion of ACX3 is related to the ASDP, ACX-3 is analyzed in this EIS.

Separate from ACX3, the ASDP also proposes to add a new 31,500-gallon (750-bbl) corrosion inhibitor storage tank, in secondary containment, at APF-1. The added corrosion inhibitor capacity would support corrosion inhibitor distribution to the production pads. This tank addition is included in all alternatives.

TABLE 2.3-12-1 POTENTIAL SCHEDULE FOR PROCESSING FACILITY EXPANSION

Year	Drill Sites in Production	Expansion Activity	Projected Total Processing Capacity at CD-1
2004	CD-1 and 2	ACX1	Oil: 105,000 bbls/day Gas: 180 mmscfd Water: 98,000 bbls/day
2004/2005	CD-1 and 2	ACX2	Oil: 145,000 bbls/day Water: 133,000 bbls/day
2010	CD-1, 2, 3, 4, and 6	ACX3	Gas: 270 or 360 mmscfd

Source: CPAI 2003j

2.3.12.3 Full-Field Development Scenario Processing Facilities

New HPFs would have to be built if additional production pads are developed farther west because three-phase flow from the wells is limited to a maximum distance of approximately 25 to 30 miles without processing and pump station support (Michael Baker, Jr. 2002e). The new HPFs would likely have structures, equipment, personnel, and air traffic similar to those at APF-1 and would have a footprint roughly equal in size. For purposes of analysis, the BLM has assumed that HPF-1 and HPF-2, in all alternatives other than the No Action Alternative, would be comparable in size and other design aspects to APF-1. The size of the FFD HPF pads could be reduced relative to APF-1, dependent on whether they are road-connected to the existing Alpine Development Project and dependent on the processing needs of the produced fluids handled. In the road-connected scenarios, FFD Alternatives A and C, there could be opportunities to share infrastructure such as maintenance facilities with APF-1. The roadless development scenario such as FFD Alternative D and the non-interconnected road development, FFD Alternative B, would necessitate replication of all the Alpine Development Project infrastructure and equipment at the isolated sites within the National Petroleum Reserve-Alaska (PAI, 2002c).

The following infrastructure is currently installed at APF-1, and is assumed to reflect what would be installed at the HPFs:

Employee camp

- Wastewater treatment system
- Lake water supply
- Diesel fuel supply
    - –Arctic heating fuel – 15,000 gallon
    - –Arctic heating fuel – 15,000 gallon
    - –Arctic heating fuel – 15,000 gallon
    - –Arctic heating fuel – 15,000 gallon (ADEC 2003b)
- Drilling mud plant
- Processing facilities
    - –Generators
    - –Compressors
    - –Gas strippers
    - –Heat exchangers
    - –Slug catchers
    - –Separators
    - –Flare system
    - –Control room
- Tankage in secondary containment
    - –Methanol – 31,500 gallon (750 bbl)
    - –Methanol – 21,200 gallon (500 bbl)
    - –Crude flowback tank 1 – 15,200 gallon (360 bbl)
    - –Crude flowback tank 2 – 15,200 gallon (360 bbl)
    - –Crude frac tank 1 – 29,400 gallon (700 bbl)
    - –Crude frac tank 2 – 29,400 gallon (700 bbl)
    - –Corrosion inhibitor – 10,700 gallon (25 bbl)
    - –Corrosion inhibitor – 31,500 gallon (750 bbl)
    - –Demulsifier – 10,700 gallon (25 bbl)(ADEC, 2003b)
- 5,000-foot airstrip
- Heavy-equipment shop
- Various equipment (rolling stock)
- Drilling shop
- Machine shop
- Warehouse for offices and inventory
- Cold storage tent
- New construction warehouse
- Class ID well
- Class IID well
- Emergency response center
- Medical clinic
- Spill response equipment (PAI 2002c)

Processing facility buildings, and other occupied structures would be designed to building codes appropriate for each facility. The designs would take into account many factors, such as temperature, wind, precipitation, seismic, and the many environmental factors discussed in this EIS. Production facilities, as with other facilities on BLM lands, are prohibited within 500 feet of a water body or within distances specified for certain areas identified in Stipulation 39 of the Northeast National Petroleum Reserve-Alaska IAP/EIS ROD (BLM and MMS 1998b). Pads will be sited and oriented to minimize the length perpendicular to sheet flow. The pad construction would proceed similar to that described in Section 2.3.3.2 for production pads.

2.3.13 Specific Procedures for the Applicant's Proposed Action

In addition to the features common to all alternatives described above, additional specific procedures would be followed in all alternatives. These specific procedures are presented in Table 2.3.13-1.

TABLE 2.3.13-1 PROJECT SPECIFIC PROCEDURES

General Topic	Procedure
Construction-ground disturbance	A cultural resource survey would be conducted prior to any ground disturbing activity. If cultural resources are found on National Petroleum Reserve-Alaska lands BLM would be notified and work would be suspended in the immediate area until written authorization to proceed is obtained.
Cultural resources	Oil field workers would be trained not to disturb cultural resources or paleontological sites.
Cultural resources	A ¼-mile buffer would be observed around known cultural resources.
Cultural resources	An archeologist would periodically visit cultural resources found within ¼-mile of the proposed project to monitor their condition and the effectiveness of the buffer zone.
Cultural resources	If recommended by State Historic Preservation Office (SHPO), a cultural resources management plan would be developed for sites less than ¼-mile from the proposed project.
Routing of pipelines, gravel roads, footprints of facility gravel pads	SHPO surveys have been completed for pipeline, road and pad locations.
Routing of ice roads	Archeological/cultural reconnaissance would be done for ice road routes.
Noise abatement	Mufflers and other measures would be used to abate noise from exhaust systems of engines and turbines.
Air emission abatement	Air pollution control equipment on construction equipment and vehicles would be maintained according to manufacturer's specifications.
Fish and wildlife resources	Oil field workers would be forbidden from interfering with wildlife by feeding, approaching, or harassing.
Fish and wildlife resources	No-fishing and no-hunting policies would be adopted for oil field workers to restrict non-resident taking of resources.

2.4 DESCRIPTION OF ALTERNATIVES

A description of alternatives follows in Sections 2.4.1 through 2.4.6. Section 2.4.1 provides detailed information about Alternative A. Subsection 2.4.1.1 describes CPAI's proposed action, and Subsection 2.4.1.2 describes the FFD scenario. Sections 2.4.2 through 2.4.6 provide discussion of how Alternatives B, C, D, and E differ from Alternative A, for both the applicant's proposed action and the FFD scenario. Except where specifically indicated in the description of the alternative, components of alternatives are the same as those for Alternative A.

2.4.1 Alternative A – Applicant's Proposed Action

2.4.1.1 Alternative A – CPAI Development Plan

This description is consistent with the applicant's proposed action as submitted in March 2004. Five production pads, CD-3 through CD-7, would be built, and produced fluids would be transported by pipeline to be processed at APF-1 (see Figure 2.4.1.1-1). Gravel roads would connect CD-4 through CD-7 to CD-1. CD-3 would be accessed by ice road or by air. Gravel used for construction of roads, pads, and airstrips would be obtained from the existing ASRC Mine Site and Clover. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. CD-3 would be the only new pad with an airstrip. Aboveground pipelines would be supported on VSMs and would be at elevations of at least 5 feet above tundra. Powerlines would be supported by cable trays placed on the pipeline VSM, except for a powerline suspended from poles between CD-6 and CD-7. Industry, local residents, and government would be allowed access to the gravel roads.

CD-6 and it access road and pipelines and the powerline from CD-6 to CD-7 would be within a 3-mile setback from Fish Creek in which the BLM's Northeast National Petroleum Reserve-Alaska IAP/EIS ROD (BLM and MMS 1998b) (Stipulation 39[d]) prohibits permanent oil facilities. This alternative would provide for an exception to this provision to allow location of CD-6 and its associated road, powerline, and pipeline within the setback. Additional exceptions would be required to locate oil infrastructure within 500 feet of some water bodies (Stipulation 41) and to locate roads between separate oilfields (Stipulation 48). In addition, although the BLM does not interpret the first sentence of Stipulation 48 to apply to the applicant's proposed action (i.e., the agency does not consider the road between CD-1 and CD-2 or the additional road to CD-4 to constitute a connection to a "road system" outside the Northeast National Petroleum Reserve-Alaska planning area), if it is determined that this sentence applies in this case, the BLM will modify Stipulation 48 to allow the applicant's proposed road from public land connecting to the existing road at APF-1. Finally, the USACE would have to determine that the applicant's proposed alternative for a road to CD-4 meets the intent of Special Condition 10 of its 1998 permit that authorized the placement of fill associated with the construction of the Alpine Development Project. Special Condition 10 requires roadless development in the Colville Delta unless an environmentally preferable alternative is available or roadless development is infeasible, and that any alternative dependent on roads must be approved by the USACE as preferable to a roadless alternative.

ALTERNATIVE A – ROADS

There is no proposed road to CD-3. As proposed, access to CD-4 would consist of a gravel road connecting the drill site to the road between CD-1 and CD-2. The road alignment would follow a naturally occurring ridge spanning 80 percent of the route (Figure 2.4.1.1-2). The top of the ridge lies above typical spring break-up water levels. The remaining 20 percent of the route is on discontinuous sections of the ridge that maintain, though not as prominently, separation of the drainage paths for the Nigliq and Sakoonang channels. Road segments along the discontinuous ridge would be provided with slideslope protection, geotextile, revetment, and other measures (as needed) to protect the facilities from erosion that might result from high-water events, including wind/wave run-up, storm surge, and ice run-up and impact associated with break-up flooding. The southernmost portion of the road bisects a lake at a relatively narrow point between two basins. Typical slope protection of the road at the lake near CD-4 is shown in Figure 2.4.1.1-3. The lake crossing is approximately 350 to 425 feet wide and 8 feet deep (Figure 2.4.1.1-4). Cross-flow culvert placement for the lake crossing is shown in Figure 2.4.1.1-5.

Proposed access to CD-5, CD-6, and CD-7 consists of a gravel road connecting to the existing CD-2 pad. The road alignment would avoid water bodies, routing 200 feet or more from them where possible. The road would cross the Nigliq Channel, the Ublutuoch River, and several smaller unnamed drainages. Industry, government agencies, and local residents would use the roads (see Bridge and Culverts discussion under Alternative A – Production Pads in this section).

ALTERNATIVE A – PIPELINES

The new pipeline corridor from CD-3 would extend approximately 6.5 miles south to APF. The route follows naturally occurring higher ground, crossing narrow portions of three distributary channels (Ulamnigiaq, Tamayayak, and Sakoonang) of the Colville River Delta (PAI 2002a).

The new pipeline corridor from CD-4 would extend approximately 2,500 feet east and then north parallel to the existing Alpine Sales Oil Pipeline on new VSMs to APF, for a total length of 3.6 miles (Figure 2.4.1.1-1). The existing Alpine Sales Oil Pipeline throughout this area is 5 feet or more above the tundra. New pipeline VSMs for the section parallel to existing pipelines would be aligned to match existing VSMs to avoid a picket-fence effect that might impede caribou movement.

The pipelines connecting CD-3 to CD-1 would consist of a 16-inch-diameter, three-phase (oil, water, and gas) production line; a 6-inch-diameter gas MI line; an 8-inch-diameter water line; a 6-inch-diameter lift gas line; and a 2-inch-diameter products line. Between CD-4 and CD-1, there would be a 14-inch production line and all other lines would be the same as CD-3, except there would be no products line (5/6/04 email from Sally Rothwell to Jim Ducker; CPAI 2004).

Pipelines connecting to CD-5 and CD-6, and CD-7 would consist of a 16- to 24-inch-diameter, three-phase (oil, water, and gas) production line; a 6- to 10-inch-diameter gas MI line; an 8- to 14-inch-diameter seawater injection line; and a 6-inch-diameter lift gas line, possibly.

Pipelines to the production pads would have to cross several drainages, including the 1,200-foot-wide Nigliq Channel. The pipelines would generally follow an alignment separate from the access road, except over the Nigliq Channel, where the pipeline and road would be co-located on the same bridge structure.

ALTERNATIVE A – PRODUCTION PADS

AIR-SUPPORTED PADS

CD-3

The CD-3 production pad would be between West Ulamnigiaq and East Ulamnigiaq channels. A CD-3 site map is provided as Figure 2.4.1.1-6. The CD-3 production pad would be located adjacent to the southwest end of a small lake (M9313) on the highest terrain in the area. The CD-3 production pad would be situated at least 200 feet from surrounding water bodies (PAI 2002a).

The CD-3 production pad would consist of a production pad connected to an airstrip and apron/taxiway by an access road. The area covered by these facilities is presented in Table 2.4.1-1. No year-round ground access to the site is planned. Operators based at CD-1 would access the CD-3 drill site via small aircraft or helicopter, by using the gravel airstrip (CPAI 2003a). Operators could also use a boat for seasonal emergency access to CD-3, and an ice road for routine winter-season access.

The size of the CD-3 production pad would include space for staging of materials during the winter ice road season. Details on the size of production pads are presented in Table 2.4.1-1.

TABLE 2.4.1-1 ALTERNATIVE A – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		Airstrips And Apron/Taxiways/Boat Launches		Totals	
Site	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**
CD-3	110	12.6	144	18.0	254	30.6
CD-4	112	9.3	16	1.4	128	10.7
CD-5	78	9.1	0	0.0	78	9.1
CD-6	78	9.1	0	0.0	78	9.1
CD-7	78	9.1	0	0.0	78	9.1
Total	**456**	**49.2**	**160**	**19.4**	**616**	**68.6**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

A winter-development drilling program is proposed by the applicant. This winter drilling program involves a minimum of 100 days per season and would allow access by air and ice road for emergency relief well purposes. The drilling rig would be transported, before break-up, to other sites for use during the summer. Development of CD-3 would require five to seven winter drilling seasons from January until May to complete the development program (CPAI 2003a).

In addition to the typical facilities for all production pads, CD-3 would include an emergency power generator.

ROAD-SUPPORTED PADS

CD-4, CD-5, CD-6, and CD-7 pads would be located south and west of the existing facilities. CD-4 would be located west of the existing Alpine Sales Oil Pipeline corridor and east of the Nigliq Channel. CD-5 would be located approximately 6 miles south-southwest of CD-1 and west of the Nigliq Channel. CD-6 would be located approximately 15 miles southwest of CD-1. CD-7 would be located approximately 20 miles southwest of CD-1. Site maps of CD-4 through CD-7 are presented in Figures 2.4.1.1-7 through 2.4.1.1-10. Production pads would be situated at least 200 feet from surrounding water bodies (PAI 2002a).

Crews based at APF-1 would service and maintain the production pads. The CD-4 development-drilling program would consist of up to 32 wells drilled during the summer by the same rig that would drill wells at CD-3 in the winter (CPAI 2003a; PAI 2002a).

ICE ROADS

Annual ice roads would be built from CD-1 to CD-3 and CD-1 to the Kuparuk Oilfield road system during the construction and development-drilling phase of the applicant's proposed action, to provide seasonal access and resupply. Well workovers and other drilling activities would be conducted every few years during the life of the facility, and an ice road would be needed to support these operations.

During the construction phase for CD-4, CD-5, CD-6, and CD-7, a winter ice road system from APF-1 and the Kuparuk Oilfield would be necessary to support gravel placement and facilities construction.

Fresh water will be required for construction of an ice road system to support placement of the gravel fill and pipelines during the winter. Approximately 1 million gallons of water typically are used to construct 1 mile of ice road. Ice aggregate and water for ice roads would be obtained from lakes and river channels for which permits have been obtained consistent with state and federal requirements. Table 2.4.1-2 shows the estimated water usage by year for ice roads.

Development of satellites in the CRU will utilize existing Alpine water use permits (CPAI 2002b). Additional permitted water sources may be used in accordance with permit stipulations. In 2003, the ADNR issued permanent water rights status for seven lake near CD-1 (CPAI 2003a). CPAI may apply for water rights for longer-term water sources at other locations. Figure 2.4.1.1-11 shows authorized lakes within the Plan Area. Lakes in the CRU and National Petroleum Reserve-Alaska are identified in Figures 2.4.1.1-12 and 2.4.1.1-13, respectively. Water use for exploration and development activities and for ice road, pad, and airstrip construction over state land is authorized under ACMP General Concurrence GC-8 and General Concurrence GC-34.

Estimated water usage by year for ice roads, pads, and airstrips follows in Table 2.4.1-2.

TABLE 2.4.1-2 ALTERNATIVE A – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Annual Total Ice Road (miles) and Water Usage (million gallons)
2005	47	0	47
2006	34	10	44
2007	67	14	81
2008	31	10	41
2009	44	10	54
2010	16	10	26
2011	0	10	10
TOTAL	**239**	**64**	**303**

Source: CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

BRIDGES AND CULVERTS

A road and pipeline bridge approximately 1,200 feet long would cross the Nigliq Channel (Figure 2.4.1.1-14). An approximately 140-foot-long road bridge would be built across the Ublutuoch River (Figure 2.4.1.1-15). Culverts or minor bridges would be required at smaller water crossings. Culverts would be installed when the road is constructed. Additional culverts may be installed after break-up if ponding occurs near the road.

A culvert battery is proposed for placement in Lake L9323 for road access to CD-4. The water is 8 feet deep at the culvert location and shallower along the road alignment. (Figure 2.4.1.1-4). The road slideslopes are projected to be 2H:1V in the area of the lake crossing and 2H:1V in the other areas.

ALTERNATIVE A – QUANTITY ESTIMATES

Primary access to the five proposed production pads is by a combination of air support and gravel roads. Table 2.4.1-3 provides the estimated gravel quantities required for production pad construction under Alternative A and also provides estimates of road mileage and yards of gravel required for construction of road segments connecting the proposed production pads and existing Alpine Development Project. Table 2.4.1-4 shows the pipeline lengths and diameters associated with the ASDP under Alternative A. Estimated vehicle traffic and aircraft flights during each of the three phases of the applicant's proposed action—construction, drilling, and operations—are provided in Table 2.3.10-1.

TABLE 2.4.1-3 ALTERNATIVE A – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
CD-1 to CD-4	3.5	210.0	25.3
CD-1 to CD-6	14.7	761.0	96.4
CD-5 access spur	0.1	5.0	0.6
CD-6 access spur	0.4	19.0	2.3
CD-6 to CD-7	7.3	376.0	47.6
TOTAL	**26.0**	**1371.0**	**172.2**

Notes:
32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.
Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.
Coverage and quantity based on CPAI permit application data (CPAI 2004a) and calculations using GIS measurements.

TABLE 2.4.1-4 ALTERNATIVE A – LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	B	624
CD-1 to CD-4	4.5	A	432
CD-1 to CD-2	2.4	A	230
CD-2 to CD-6	15.0	A	1,440
CD-6 access spur	0.2	A	19
CD-6 to CD-7	7.0	A	672
TOTAL	**35.6**		**3,418**

Notes:
A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.
B = Pipelines included in “A” above and 2-inch products.

CONSTRUCTION AND OPERATIONS SCHEDULE

CPAI proposes to construct the facilities on the schedule indicated in Table 2.4-5. As detailed design progresses, the schedule may change. However, the identified work would occur in the indicated season, if not in the indicated year, or in the indicated sequence of pad development. Under the proposed construction schedule, construction of an ice road, the gravel road, the production pad, and the pipelines typically would be completed in the first and second winters after approval of the applicant’s proposed action for each individual production pad. After gravel placement, development drilling and workover operations would begin in the second winter and would continue intermittently throughout the life of the field. Final road compaction and grading, installation of some facilities and pipelines, and start-up of oil production would be completed in the second year.

2.4.1.2 Alternative A – Full-Field Development Scenario

Two HPFs (each including production facilities) and 22 HPs would be constructed in the Plan Area, in addition to the five production pads proposed by CPAI. Gravel roads would connect all but six production pads. Five productions pads in the lower Colville River Delta (CD-3, HP-7, HP-12, , HP-14, and HP-15) and one near the Kogru River (CD-29) would be designed with airstrips for access, instead of roads. Construction and operation strategies described for the applicant’s proposed action would apply for the FFD scenario. Exceptions to the stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS ROD would be necessary to allow placement of facilities in certain areas. Figure 2.4.1.2-1 presents Alternative A – FFD pad, road, and pipeline locations.

ALTERNATIVE A – FFD DESCRIPTION

For purposes of analysis, this EIS provides an FFD scenario for each alternative. The scenario describes the potential development that would be associated with HPs and HPFs. The design of the FFD scenario for Alternative A would assume construction of the five pads proposed by CPAI as described for Alternative A and would mimic the design for infrastructure associated with those five pads. Under Alternative A, roads would link 17 HPs to 2 HPFs and to APF-1.

Suitable gravel sources within the National Petroleum Reserve-Alaska remain an uncertainty. The only identified source thus far is Clover (Figure 2.4.1.2-1). Further exploration could identify other sources within the FFD area, providing flexibility and cost savings to road and pad development scenarios.

No schedule is provided for construction of this hypothetical infrastructure. However, construction of infrastructure on this scale would likely occur over a matter of decades.

TABLE 2.4.1-5 ASDP CONSTRUCTION SCHEDULE BY PRODUCTION PAD

Task	2005		2006		2007		2008		2009		2010		2011	
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
CD-3														
Lay gravel for production pad	X													
Drilling	X		X		X		X		X		X		X	
Install VSMs for pipelines	X													
Install pipelines			X											
Install powerlines			X											
Install module piles	X													
Install pipeline bridge foundations	X													
Construct pipeline bridges			X											
Work gravel on pad		X		X										
Install surface facilities			X											
Set modules			X											
Production startup				X										
CD-4														
Lay gravel for road	X													
Lay gravel for production pad	X													
Drilling				X		X								
Install VSMs for pipelines	X													
Install pipelines	X													
Install powerlines	X													
Install module piles	X													
Construct Bridges	X													
Work gravel on pad/roads		X												
Install surface facilities			X											
Set modules			X											
Production startup				X										

TABLE 2.4.1-5 ASDP CONSTRUCTION SCHEDULE BY PRODUCTION PAD (CONT'D)

Task	**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**	
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
CD-6														
Lay gravel for road					X									
Lay gravel for production pad					X									
Drilling							X	X	X					
Install VSMs for pipelines					X									
Install pipelines							X							
Install powerlines					X									
Install module piles					X									
Install bridge foundations					X									
Construct bridges					X									
Work gravel on pad/roads						X								
Install surface facilities							X							
Set modules							X							
Production startup								X						
CD-7														
Lay gravel for road									X					
Lay gravel for production pad									X					
Drilling											X	X	X	
Install VSMs for pipelines									X					
Install pipelines											X			
Install powerlines											X			
Install module piles									X					
Install bridge foundations									X					
Construct bridges									X					
Work gravel on pad/roads										X				
Install surface facilities											X			
Set modules											X			

TABLE 2.4.1-5 ASDP CONSTRUCTION SCHEDULE BY PRODUCTION PAD (CONT'D)

Task	2005		2006		2007		2008		2009		2010		2011	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
CD-7 cont'd														
Production startup												X		
CD-5														
Lay gravel for road									X					
Lay gravel for production pad									X					
Drilling											X	X	X	
Install VSMs for pipelines									X					
Install pipelines									X					
Install powerlines									X					
Install module piles									X					
Work gravel on pad/roads										X				
Install surface facilities											X			
Set modules											X			
Production startup												X		

ALTERNATIVE A – FFD QUANTITY ESTIMATES

In Alternative A, the 5 proposed production pads (CD-3, CD-4, CD-5, CD-6, and CD-7) and 13 HPs (HP-1, HP-3, HP-4, HP-5, HP-6, HP-7, HP-8, HP-9, HP-11, HP-12, HP-13, HP-14, and HP-15) -would tie-in by pipeline to APF-1. HP-2, HP-10, HP-16, HP-17, and HP-19 would tie in by pipeline to HPF-1. HP-18, HP-20, HP-21, and HP-22 would tie in by pipeline to HPF-2. Under Alternative A, airstrips and winter ice roads, rather than gravel roads, would provide access to CD-3, HP-7, HP-12, HP-13, HP-14, and HP-22. A gravel road network would interconnect all other pads and processing facilities.

Estimates of the areas that would be covered by gravel and the volume of gravel required to construct the hypothetical facilities are presented in Tables 2.4.1-6 and 2.4.1-7. Lengths and diameters of pipelines are shown in Table 2.4.1-8. Estimated miles of annual ice roads are shown in Table 2.4.1-9**,** assuming a hypothetical sequence of development for analysis purposes.

TABLE 2.4.1-6 ALTERNATIVE A – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	PRODUCTION PAD		AIRSTRIP AND APRON/TAXIWAY		TOTALS	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-1	78	9.1	—	—	78	9.1
HP-2	78	9.1	—	—	78	9.1
HP-3	78	9.1	—	—	78	9.1
HP-4	78	9.1	—	—	78	9.1
HP-5	78	9.1	—	—	78	9.1
HP-6	78	9.1	—	—	78	9.1
HP-7	110	12.6	162	21.5	272	34.1
HP-8	78	9.1	—	—	78	9.1
HP-9	78	9.1	—	—	78	9.1
HP-10	78	9.1	—	—	78	9.1
HP-11	78	9.1	—	—	78	9.1
HP-12	110	12.6	162	21.5	272	34.1
HP-13	110	12.6	162	21.5	272	34.1
HP-14	110	12.6	162	21.5	272	34.1
HP-15	78	9.1	—	—	78	9.1
HP-16	78	9.1	—	—	78	9.1
HP-17	78	9.1	—	—	78	9.1
HP-18	78	9.1	—	—	78	9.1
HP-19	78	9.1	—	—	78	9.1
HP-20	78	9.1	—	—	78	9.1
HP-21	78	9.1	—	—	78	9.1
HP-22	149	17.6	162	21.5	311	39.1
HPF-1	317	36.3	228	29.4	545	65.7
HPF-2	317	36.3	228	29.4	545	65.7
TOTAL	**2549**	**295.3**	**1266**	**166.3**	**3815**	**461.6**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, aprons, and roads; 2H:1V slideslopes.

Total may not be exact because of rounding.

TABLE 2.4.1-7 ALTERNATIVE A – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
HP-1 to CD-6/5 road	2.5	103	16.1
CD-7 HP-2	2.8	115	18.3
HP-3 to CD-6/5 road	4.3	177	28.1
CD-4 to HP-4	2.5	103	16.2
CD-2 to HP-5	3.0	123	29.0
HP-6 to CD-5/6 road	5.0	206	32.7
HP-8 to HP-6/HP-9 road	3.9	160	25.1
HP-6 to HP-9	7.2	296	46.7
HP-10 to CD-7/HP-2 road	7.3	300	47.0
HP-9 to HP-11	8.7	358	56.4
CD-6 to HP-15	10.4	427	67.3
HPF-1 to HP-16	5.5	226	35.7
HP-16 to HP-17	6.6	271	42.8
HP-18 to HPF-1	7.8	321	50.7
HP-17 to HP-19	9.1	374	59.3
HP-20 to HPF-2/HP-18 road	8.9	366	57.6
HP-21 to HPF-2	9.8	403	63.4
HPF-1 to CD-6/7 road	5.8	238	37.7
HPF-2 to HP-18	10.7	440	69.7
TOTAL	**121.8**	**5,006**	**799.8**

Notes:
32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.
Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope
Coverage calculation assumes 52-foot wide toe of slope-to-toe of slope road width, 2H:1V slideslope

TABLE 2.4.1-8 ALTERNATIVE A – FFD ESTIMATED LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
HP-1 to CD-6/5 line	2.5	A	242
HP-2 to CD-7	2.7	B	260
HP-3 to CD-6/5 line	4.5	A	433
HP-4 to CD-4	2.2	A	215
HP-5 to CD-2	3.1	A	295
HP-6 to CD5/6 road	4.7	B	451
HP-7 to CD-3/1 pipeline	1.5	B, D	143
HP-8 to HP-6/HP-9 road	4.0	A	387
HP-9 to HP-6	7.1	B	680
HP-10 to CD-7/HP-2 line	7.1	A	685
HP-11 to HP-9	8.7	A	840
HP-12 to HP-7	6.0	B, D	575
HP-13 to HP-12	4.3	A, D	412
HP-14 to HP-12	5.2	A, D	503
HP-15 to CD-6	10.6	A	1,016
HP-16 to HPF-1	5.4	B	517
HP-17 to HP-16	6.8	B	650
Spine, HP-18 to HPF-1	7.8	C	753
HP-19 to HP-17	9.0	A	860
HP-20 to HPF-2/HP-18 road	8.9	A	854
HP-21 to HPF-2	10.0	B. D	965
HP-22 to HP-21	11.1	A, D	1,069
Spine, HPF-2 to HP-18	10.7	B, C	1,029
Spine, HPF-1 to CD-6/7 road	6.2	B, C	577
TOTAL	**150.1**		**14,411**

Notes:
A = Pipelines include 18-inch produced fluids, 8-inch gas, 10-inch water, and 6-inch lift gas.
B = Pipelines include 24-inch produced fluids, 10-inch gas, 14-inch water, and 6-inch lift gas.
C = 14-inch sales oil and 12-inch seawater supply pipeline.
D = 2-inch products line to non-roaded production pads.

TABLE 2.4.1-9 ALTERNATIVE A – FFD ICE ROAD ESTIMATES

Construction Timeframe	Year	Facilities Constructed	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Total Annual Ice Road (miles) and Water Usage (million gallons)
2011 to 2015	2011	HP-4 & HP-5	21	NA	21
	2012	HP-7	16	5	21
	2013	HP-12	21	7	28
	2014	HP-13	27	5	32
	2015	HP-14	28	6	34
2016 to 2018	2016	HP-1	9	NA	9
	2017	HP-3	14	NA	14
	2018	HP-15	28	NA	28
2019 to 2022	2019	HPF-1 & HP-2	29	NA	29
	2020	HP-10	20	NA	20
	2021	HP-16	13	NA	13
	2022	HP-17 & HP-19	35	NA	35
2023 to 2026	2023	HPF-2 & HP-18	52	NA	52
	2024	HP-20	40	NA	40
	2025	HP-21	32	NA	32
	2026	HP-22	30	13	43
2027 to 2030	2027	HP-6	15	NA	15
	2028	HP-8	19	NA	19
	2029	HP-9	13	NA	13
	2030	HP-11	33	NA	33
		TOTAL	**495**	**36**	**531**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Estimates assume gravel supply from the ASRC Mine Site, Clover Potential Gravel Source, and hypothetical future gravel source(s).
Assumes ice roads annually to all sites not connected via gravel roads.

2.4.2 Alternative B – Conformance with Stipulations

2.4.2.1 Alternative B – CPAI Development Plan

Except for those aspects specifically discussed below, the components of Alternative B are the same as those for Alternative A. Most differences between the two alternatives are based on the theme that Alternative B would alter the applicant's proposed action to conform completely to Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations (see Appendix D). Accordingly, Alternative B would alter the applicant's proposed action on BLM-managed lands by:

- Moving proposed permanent oil infrastructure to a distance at least 3 miles from Fish Creek (Stipulation 39[d]). This activity requires that CD-6 and associated roads and pipelines be moved from within the setback.

- Moving proposed permanent oil infrastructure, except essential pipeline and road crossings, to a distance of at least 500 feet from water bodies (Stipulation 41). Roads and pipelines would be moved to conform to this provision to the maximum extent possible

- Eliminating roads to a road network outside BLM-managed lands in the National Petroleum Reserve-Alaska (Stipulation 48). Road connection between CD-6 and CD-7, and other facilities are eliminated.

In addition, access to roads would be restricted to industry and government agency personnel only.

Roads would be built to connect CD-4 to APF-1 and CD-7 to CD-6. A pipeline-only bridge would span the Nigliq Channel. Airstrips would be built at both CD-5 and CD-6, in addition to the one at CD-3. Access to CD-5, CD-6, and CD-7 during the construction and drilling phases would require ice roads and an ice bridge across the Nigliq Channel. The size of the gravel production pads at CD-5 and CD-6 would be increased to approximately 11.6 acres from the approximately 9.1 acres proposed in Alternative A to allow for staging of equipment and supplies airlifted or hauled in over ice roads (Table 2.4.1-9). A 2-inch products pipeline would be added to serve CD-5, CD-6, and CD-7, as well as CD-3**,** because gravel roads would not connect back to APF-1. Larger bulk storage tanks for corrosion inhibitor and other materials would be installed at CD-3, CD-5, CD-6, and CD-7. These bulk liquids would be delivered by tanker truck over ice roads and stored for use throughout the year, or could be batched through the 2-inch products pipeline. Mud plants would be located at DC-5 and CD-6. The mud plant at CD-6 would also support drilling at CD-7. Figure 2.4.2.1-1 presents the Alternative B site map.

ALTERNATIVE B – QUANTITY ESTIMATES

Table 2.4.2-1 provides the estimated gravel quantities required for the production pad and airstrip under Alternative B, and Table 2.4.2-2 contains annual projected water usage for the ice road. Estimated areas that would be covered by gravel and length of the road segments are presented in Table 2.4.2-3. Lengths and diameters of pipelines are shown in Table 2.4.2-4.

ALTERNATIVE B – CONSTRUCTION AND OPERATIONS SCHEDULE

The construction and operations schedule for Alternative B would be essentially the same as that for Alternative A (Table 2.4.1-5). Alternative B would differ from Alternative A by laying gravel for adjoining airstrips, airstrip aprons, and roads to the airstrips at the same time that gravel is laid for CD-5 and CD-6, and no gravel would be laid for a road between CD-2 and CD-6.

2.4.2.2 Alternative B – Full-Field Development Scenario

ALTERNATE B – FFD DESCRIPTION

Alternative B for FFD would alter the FFD scope to conform completely to Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations. Figure 2.4.2.2-1 presents the Alternative B – FFD pad, road, and pipeline locations. In accordance with Stipulation 41, permanent oil infrastructure would be placed 500 feet or more from water bodies. Stipulation 31 sets aside the Teshekpuk Lake Surface Protection Area. Conformance would preclude development in the northwesternmost part of the Plan Area near the Kogru River. This change would eliminate hypothetical CD-29.

TABLE 2.4.2-1 ALTERNATIVE B – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		Airstrips and Apron/Taxiways/Boat Launches		Totals	
Site	Gravel Qty (1,000 cy)	Coverage (acres)	Gravel Qty (1,000 cy)	Coverage (acres)	Gravel Qty (1,000 cy)	Coverage (acres)
CD-3	110	12.6	144	18.0	254	30.6
CD-4	112	9.3	16	1.4	128	10.7
CD-5	149	17.6	196	24.3	345	41.9
CD-6	149	17.6	201	24.9	350	42.5
CD-7	78	9.1	0	0.0	78	9.1
TOTAL	**598**	**66.2**	**557**	**68.6**	**1155**	**134.8**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.2-2 ALTERNATIVE B – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Total Annual (miles) and Water Usage (million gallons)
2005	44	5	49
2006	39	5	44
2007	39	5	44
2008	51	5	56
2009	68	5	73
2010	0	5	5
2011	0	0	0
TOTAL	**241**	**30**	**271**

Notes:

Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.

Mileage estimated by straight line between locations + 25% to account for routing around land features.

Ice roads typically require 1,000,000 gallons per mile constructed.

Construction estimate includes a 28-mile annual ice road from Kuparuk to CD-1.

Estimates assume gravel supply from the ASRC Mine Site and Clover Potential Gravel Source.

Assumes ice roads annually, during construction and drilling, to all sites not connected via gravel roads.

TABLE 2.4.2-3 ALTERNATIVE B – ESTIMATED GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
CD-1 to CD-4	3.5	210	25.3
CD-6 to CD-7	6.6	273	43.4
TOTAL	**10.1**	**483**	**68.7**

Notes:

32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.

Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.

TABLE 2.4.2-4 ALTERNATIVE B – ESTIMATED LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	B	624
CD-1 to CD-4	4.5	A	432
CD-2 to CD-5	6.2	B	595
CD-5 to CD-6	10.1	B	970
CD-6 to CD-7	6.8	A	653
CD-1 to CD-2	2.4	B	230
TOTAL	**36.5**		**3504**

Notes:
A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.
B = Pipelines included in "A" above and 2-inch products.

Stipulation 39 requires setback of permanent oil and gas facilities from Fish Creek (3 miles below Section 21, T11N, R1E, U.M. and 1/2 mile upstream from there), Judy Creek (1/2 mile), and the Colville River (1 mile). Conformance with Stipulation 39 would require moving the CD-6 drill site and associated road away from Fish Creek. Future development also would have to stay out of these setbacks. For relatively narrow setbacks, this restriction normally would not deny oil companies access to oil. However, oil accumulations centered within a large setback area such as that for Fish Creek may not be able to be reached economically with currently available technology, and associated developments would not be built. For example, HPF-1 is located within the 3-mile setback around Fish Creek. Under Alternative B, this HPF probably would not be developed because the resource that would justify its construction would be economically unreachable from outside the setback. Without a processing facility in this area of the Plan Area, smaller oil accumulations would become uneconomic. In the hypothetical scenario of this EIS, HP-10 and HP-19 probably would be uneconomic to develop. The economic analysis of this alternative in Chapter 4 will analyze the impact of the elimination of HPF-1.

To ensure thorough analysis of FFD, however, Chapter 4 also will assume that an HPF can be located just outside the 3-mile Fish Creek setback. Figure 2.4.2.2-1 reflects this scenario. In this figure, HPF-1 has been relocated and has absorbed HP-2. HP-1 would shift north to a location outside BLM-managed lands. Essential roads and pipelines could cross the Fish Creek and Judy Creek setbacks under existing Northeast National Petroleum Reserve-Alaska stipulations. For this scenario, the EIS hypothesizes that pipelines could cross the setbacks, but roads would be deleted or relocated. The removal of these roads is consistent with the intent of Stipulations 39 and 48.

Finally, consistent with Stipulation 48, roads would not be allowed to connect BLM-managed lands to roads on state or private lands.

Although FFD would not be altered from that described for Alternative A east of the Nigliq Channel, FFD for Alternative B would differ substantially west of the channel. Each production pad under this scenario would have its drilling product processed at the same processing facility as in Alternative A, although the pipeline routes between the pads and processing facility would change. Access to production pads on Kuukpik Corporation land would be by a road from Nuiqsut, taking advantage of the airstrip at that village, as well as the airstrip that would have been built at CD-5 as part of this alternative's scenario for development of CPAI's proposed five pads. Other airstrips in the NPR-A would be required at HPF-2, HP-11, HP-15, and HP-17, in addition to the one built at CD-6 as part of this alternative's scenario for development of the applicant's proposed action. Ice roads would be necessary to obtain access to isolated pads and road segments every winter during construction and drilling, and periodically thereafter for well workover rig access and other maintenance and operations work.

ALTERNATIVE B – FFD QUANTITY ESTIMATES

The differences between FFD Alternative A and FFD Alternative B have been described above and can be seen by comparing Figures 2.4.1.2-1 and 2.4.2.2-1. Tables 2.4.2-5 and 2.4.2-6 present the areas covered by the FFD Alternative B facilities and the estimated volume of gravel required to develop those hypothetical facilities. Table 2.4.2-7 presents the lengths and diameters of pipelines. Table 2.4.2-8 presents the water usage projected annually for ice roads, assuming a hypothetical sequence of development for analysis purposes.

TABLE 2.4.2-5 ALTERNATIVE B – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production Pad		Airstrip and Apron/Taxiway		Total	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-1	78	9.1			78	9.1
HP-2	0	0.0			0	0.0
HP-3	78	9.1			78	9.1
HP-4	78	9.1			78	9.1
HP-5	78	9.1			78	9.1
HP-6	78	9.1			78	9.1
HP-7	110	12.6	162	21.5	272	34.1
HP-8	78	9.1			78	9.1
HP-9	78	9.1			78	9.1
HP-10	78	9.1			78	9.1
HP-11	149	17.6	162	21.5	311	39.1
HP-12	110	12.6	162	21.5	272	34.1
HP-13	110	12.6	162	21.5	272	34.1
HP-14	110	12.6	162	21.5	272	34.1
HP-15	149	17.6	162	21.5	311	39.1
HP-16	78	9.1			78	9.1
HP-17	149	17.6	162	21.5	311	39.1
HP-18	78	9.1			78	9.1
HP-19	78	9.1			78	9.1
HP-20	78	9.1			78	9.1
HP-21	78	9.1			78	9.1
HP-22	0	0.0			0	0.0
HPF-1	317	36.3			317	36.3
HPF-2	371	36.3	228	29.4	599	65.7
TOTAL	**2589**	**294.1**	**1362**	**179.9**	**3951**	**474.0**

Notes:Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, aprons, and roads; 2H:1V slideslopes.
Total may not be exact because of rounding.

TABLE 2.4.2-6 ALTERNATIVE B – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
HP-1 to HP-3	4.3	177	27.7
HP-3 to CD-5 road	3.8	156	24.6
HP-4 to CD-4	2.5	103	16.1
HP-5 to CD-2	3.1	127	30.0
HP-6 to CD-5	5.6	230	35.8
HP-8 to HP-6/HP-9 road	3.8	156	24.5
HP-9 to HP-6	5.5	226	35.5
HP-10 to HPF-1/CD-7 road	7.2	296	46.4
HP-16 to HP-17	6.7	275	43.0
HP-18 to HPF-2	10.7	440	69.1
HP-19 to HP-10	13.5	555	86.7
HP-20 to HPF-2/HP-18 road	8.9	366	57.1
HP-21 to APF-3	9.8	403	63.0
HPF-1 to CD-7	4.5	185	28.9
TOTAL	**89.9**	**3,695**	**588.4**

Notes:
32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.
Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.

TABLE 2.4.2-7 ALTERNATIVE B – FFD ESTIMATED LENGTHS AND DIAMETER OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
HP-1 to HP-3/22	2.7	A, D	256
HP-2 to CD-7	0	None, no HP-2	0
HP-3 to CD-5	3.8	B, D	363
HP-4 to CD-4	2.2	A	215
HP-5 to CD-2	3.2	A	303
HP-6 to CD-5	5.6	B, D	534
HP-7 to CD-3/1	1.5	B, D	143
HP-8 to HP-6/HP-9	3.9	A, D	375
HP-9 to HP-6	7.2	B, D	688
HP-10 to HPF-1/CD-7	7.3	B	697
HP-11 to HP-9	8.7	A, D	840
HP-12 to HP-7	6.0	B, D	575
HP-13 to HP-12	4.3	A, D	412
HP-14 to HP-12	5.2	A, D	503
HP-15 to HP-3	9.5	A, D	908
HP-16 to HPF-1	5.5	B, C, D	523
HP-17 to HP-16	6.8	A, D	653
HP-18 to HP-16	7.3	C	702
HP-19 to HP-10	13.2	A	1,266
HP-20 to HPF-2/HP-18	8.9	A	854

TABLE 2.4.2-7 ALTERNATIVE B – FFD ESTIMATED LENGTHS AND DIAMETER OF PIPELINES (CONT'D)

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
HP-21 to HPF-2	9.8	A	938
HP-22 to HP-21	0	None, no HP-22	0
HPF-2 to HP-18	10.7	B, C	1,029
HPF-1 to CD-7	2.8	B, C	267
TOTAL	**135.9**		**13,044**

Notes:
A = Pipelines include 18-inch produced fluids, 8-inch gas, 10-inch water, and 6-inch lift gas.
B = Pipelines include 24-inch produced fluids, 10-inch gas, 14-inch water and 6-inch lift gas.
C = 14-inch sales oil and 12-inch seawater supply pipeline.
D = 2-inch products.

TABLE 2.4.2-8 ALTERNATIVE B – FFD ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Construction Timeframe	Year	Facilities Constructed	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Annual Total Ice Road (miles) and Water Usage (million gallons)
2011 to 2015	2011	HP-4 & HP-5	21	NA	21
	2012	HP-7	18	8	26
	2013	HP-12	21	7	28
	2014	HP-13	27	5	32
	2015	HP-14	28	6	34
2016 to 2018	2016	HP-1	33	NA	33
	2017	HP-3	6	NA	6
	2018	HP-15	15	NA	15
2019 to 2022	2019	HPF-1	17	11	28
	2020	HP-10	31	NA	31
	2021	HP-19	42	NA	42
	2022	HP-16 & 24	35	9	44
2023 to 2026	2023	HPF-2	32	NA	32
	2024	HP-18	53	10	63
	2025	HP-20	42	NA	42
	2026	HP-21	43	NA	43
2027 to 2030	2027	HP-6	22	NA	22
	2028	HP-8	24	NA	24
	2029	HP-9	18	NA	18
	2030	HP-11	37	NA	37
		TOTAL	**565**	**56**	**621**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Estimates assume gravel supply from the ASRC Mine Site, Clover Potential Gravel Source and hypothetical future gravel source(s).
Assumes ice roads annually to all sites not connected via gravel roads.

2.4.3 Alternative C – Alternative Access Routes

Alternative C differs from Alternative A principally by including a different, more southern bridge location over the Nigliq Channel, a road connection to Nuiqsut, a southerly road and pipeline route to CD-6 and CD-7, and road connections to all production pads, including those in the lower Colville River Delta. This alternative also contrasts with Alternative A by requiring a minimum pipeline height of 7 feet and placing powerlines on separate poles rather than on VSMs. The road route to Nuiqsut would allow easier use of existing Nuiqsut facilities such as the airstrip and lodging during construction and operations. The route also offers potential efficiencies if the state constructs the proposed Colville River Road it is now considering to Nuiqsut from the western end of the Spine Road system at Iceberg. For purposes of analysis Alternative C is separated into two sub-alternatives, Sub-Alternative C-1 and Sub-Alternative C-2. Sub-Alternative C-1 provides for stand-alone gravel road development as part of the applicant's proposed action, without anticipating the presence of the Colville River Road. Sub-Alternative C-2 has road alignments comparable to Sub-Alternative C-1, except it relies on the existence of a state-built gravel Colville River Road connecting Nuiqsut and the Spine Road, including a state-built bridge across the Nigliq Channel. The state road has not been built yet, but the State is actively working on a proposal with that objective. Under Sub-Alternative C-2, the applicant would not construct a vehicle bridge over the Nigliq Channel. Production pad locations for Sub-Alternatives C-1 and C-2 would be the same as those proposed in Alternative A. Exceptions to the same Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations as in Alternative A would be required. Use of roads on BLM lands would be unrestricted. Industry, government agencies, and local residents would have access to other roads.

Roads constructed across the lower Colville River Delta (to CD-3) would include extensive bridging and culverts to maintain surface flow paths and prevent damming. Roadside embankments would likely require stabilization and armoring to protect against the forces of floodwaters and ice impacts. Hydraulic modeling would be performed as part of the road design to ensure that the presence of the road would not increase the peak water surface elevations used for design at the existing CD-1 and CD-2 facilities. Roads in the lower Colville River Delta would be designed with an elevation equal to a 200-year flood with 1 foot of freeboard, in contrast to the 50-year flood with 3-feet of freeboard for the other alternatives. Roads to the lower Colville River Delta pads would use more embankment material than the typical North Slope road. Roads to production pads in the lower Colville River Delta would be designed to prevent washout. Thus, the proposed roads may require slope armoring or protection to resist hydraulic scouring forces from floodwaters. Generally, floodplain flows do not carry much velocity; however, the proposed roads would border or cross many channels that may have more aggressive flow regimes. Roadway embankment armoring could be accomplished with various methods. Conventionally, rock armoring in the form of riprap would be used. Articulated concrete mat is a matrix of concrete blocks held together by a web of concealed steel cables. Concrete mats also can be effective at limiting bank erosion. Another option would be to place sand or gravel into large geotextile bags, which are essentially large sandbags. The roads and armoring system would require annual repair and maintenance.

Several bridges would be built in the lower Colville River Delta to reach CD-3 and additional pads as part of FFD. A road to CD-3 from APF-1 would cross three channels. Roads to the four FFD HPs in the lower Colville River Delta would include more than 2 miles of bridges crossing eight channels.

Wind-drifted snow is a common concern on the North Slope, and snow blockage of culverts is a primary concern. Because break-up usually occurs before snowdrifts have melted, the culverts cannot handle flooding. Two options are available for ensuring culverts are clear and capable of handling flooding: (1) annual clearing or (2) the placement of a plywood end cap in the fall and removal of the end cap before break-up. In some cases, a battery of culverts may not be as efficient as a large multi-plate culvert, or a bridge, when life-cycle maintenance costs are considered (McDonald 1994). Ongoing monitoring would likely be required to determine if the roads in the lower Colville River Delta were affecting the Colville River Delta flow regimes and causing changes to river erosion and deposition patterns.

2.4.3.1 Alternative C, Sub-Alternative C-1 – CPAI Development Plan

SUB-ALTERNATIVE C-1 – CPAI DEVELOPMENT PLAN

SUB-ALTERNATIVE C-1 DESCRIPTION

Figure 2.4.3.1-1 depicts Sub-Alternative C-1 for CPAI's proposed pad developments. Although the pads are in the same locations as in Alternative A, access to them differs. A road, rather than an airstrip, provides access to CD-3. The bridge across the Nigliq Channel is located at an alternative crossing location originally identified by CPAI. Instead of being directly west of CD-2, the bridge is near CD-4. This bridge leads to a northern spur road to CD-5 and a southern route that has connections to Nuiqsut, CD-6, and CD-7.

Road and pipeline lengths would be greater for this alternative than for other alternatives, but infrastructure construction south and west of APF-1 would not differ markedly from that for Alternative A. The road to CD-3, however, would have to address additional engineering challenges. A road to CD-3 would have to be reachable year-round. Estimated elevations based on topographic maps at the proposed CD-3 pad indicate that the embankments would range from 5 to 16 feet. Also, the road may have to accommodate storm surges that could cause the Delta to back up from elevated sea levels offshore.

Several bridges would be required to construct a year-round gravel road between CD-1 and CD-3. Bridge lengths are shown in Table 2.4.3-1.

TABLE 2.4.3-1 SUB-ALTERNATIVE C-1 – BRIDGE LENGTHS

Road Segment	Waterbodies Crossed	Estimated Lengths (Feet)
CD-1 to CD-3	Sakoonang Tamayayak Ulamnigiaq	450 750 500

Bridges are expected to be aligned perpendicular to the channels and do not include any additional length that may be required to accommodate waterway opening requirements. Waterway opening requirements are calculated from the design flood flows at each location and thus determine the overall span length (McDonald 1994). Overall bridge lengths may be longer than estimated if detailed engineering shows additional length is necessary for flood flows.

SUB-ALTERNATIVE C-1 – QUANTITY ESTIMATES

Table 2.4.3-2 and Table 2.4.3-3 provide the estimated gravel quantities required for production pad, airstrip, and road segments construction under Sub-Alternative C-1. Table 2.4.3-4 contains additional information for ice road construction. Table 2.4.3-5 shows the estimated pipeline lengths and diameters associated with production pads under Sub-Alternative C-1. Estimated vehicle traffic and aircraft flights during each of the three phases of the applicant's proposed action—construction, drilling, and operations—are the same as Alternative A and are provided in Table 2.3.10-1.

SUB-ALTERNATIVE C-1 – CONSTRUCTION AND OPERATIONS SCHEDULE

The construction and operations schedule for Sub-Alternative C-1 would be essentially the same as that for Alternative A (Table 2.4.1-5). The primary difference would be that for Sub-Alternative C-1, gravel would be laid for a road to CD-3 at the same time as gravel is laid for that pad. CD-3 remains restricted to winter-only drilling, and CD-4 drilling would remain in the summer, on a rotation with CD-3.

TABLE 2.4.3-2 SUB-ALTERNATIVE C-1 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		Airstrips and Apron/Taxiways/Boat Launches		Totals	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
CD-3	78	9.1	2	0.1	80	9.2
CD-4	112	9.3	16	1.4	128	10.7
CD-5	78	9.1	0	0.0	78	9.1
CD-6	78	9.1	0	0.0	78	9.1
CD-7	78	9.1	0	0.0	78	9.1
TOTAL	**424**	**45.7**	**18**	**1.5**	**442**	**47.2**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.3-3 SUB-ALTERNATIVE C-1 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
Alpine to CD-3	6.4	264	41.9
Alpine to CD-4	3.5	210	25.3
CD-5 to CD-6 Primary Road	9.5	392	62.3
CD-6 to CD-7, Primary Road	6.0	246	39.2
CD-5 Pad Access Road	5.0	207	33.0
CD-6 Pad Access Road	4.4	181	28.8
CD-4 to National Petroleum Reserve-Alaska	4.1	169	26.8
CD-4/CD-5 Junction to Nuiqsut Primary Road	2.1	85	13.5
Nuiqsut Spur	1.1	44	7.0
TOTAL	**42.1**	**1798**	**277.8**

Notes:

32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.

Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.

TABLE 2.4.3-4 SUB-ALTERNATIVE C-1 – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Total Annual Ice Road (miles) and Water Usage (million gallons)
2005	67	0	67
2006	56	0	56
2007	57	0	57
2008	83	0	83
2009	63	0	63
2010	0	0	0
2011	0	0	0
TOTAL	**326**	**0**	**326**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Construction estimate includes a 28-mile annual ice road from Kuparuk to CD-1.
Estimates assume gravel supply from the ASRC Mine Site and Clover Potential Gravel Source.
Assumes ice roads annually, during construction and drilling, to all sites not connected via gravel roads.

TABLE 2.4.3-5 SUB-ALTERNATIVE C-1 – APPROXIMATE LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	A	624
CD-1 to CD-4	4.5	A	432
CD-5 to CD-5 tie-in	4.9	A	470
CD-5 tie-in to CD-1/4	4.4	A	422
Y to CD-5 tie-in	11.7	A	1123
CD-6 to Y	4.4	A	422
CD-7 to Y	5.9	A	566
TOTAL	**42.3**		**4059**

Notes:
A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.
B = Pipelines included in “A” above and 2-inch products.

2.4.3.2 Alternative C, Sub-Alternative C-2 – CPAI Development Plan

SUB-ALTERNATIVE C-2 – CPAI DEVELOPMENT PLAN

SUB-ALTERNATIVE C-2 DESCRIPTION

Sub-Alternative C-2 is similar to Sub-Alternative C-1 with respect to following the theme of gravel road access to production pads. The difference is that the proposed Colville River Road into Nuiqsut would be incorporated into ASDP access designs. The Colville River Road is proposed by the State of Alaska and is not a proposed component of Sub-Alternative C-2. For Sub-Alternative C-2 to be practicable, the Colville River Road would need to be constructed and operational by late 2009, as currently proposed by the State of Alaska. Section 4G.4.5 includes additional information regarding the proposed Colville River Road. In order to adopt Alternative C-2, the BLM would have to modify the Northeast National Petroleum Reserve-Alaska IAP/EIS (Stipulation 48) to allow roads connecting to a road system outside the National Petroleum Reserve-Alaska. The

Sub-Alternative C-1 Nigliq Channel crossing between the CD-4 road and the CD-5 road would be eliminated, in lieu of a crossing farther south at the location of the Colville River Road bridge proposed by the state. There would be no direct gravel road connection between the existing Alpine Development Project and the Colville River Road. ASDP facilities would instead be developed with two separate clusters. The eastern cluster of pads would include CD-3 and CD-4, interconnected by gravel roads to the existing Alpine Development Project at CD-1 and CD-2. The western cluster of pads would include CD-5, CD-6, and CD-7, interconnected to Nuiqsut and by the Colville River Road and Spine Road to the Kuparuk Oilfield. Equipment, supplies, and personnel destined for CD-5, CD-6, and CD-7 could be flown or trucked directly into Nuiqsut, and then transported via the Alpine road system to the desired Alpine production pad. Ice roads could be constructed for vehicle access between the eastern and western clusters of pads, and from CD-4 to Nuiqsut during the winter months.

Pipelines under Sub-Alternative C-2 would be routed similarly to those under Sub-Alternative C-1. The pipeline lengths and diameters associated with Sub-Alternative C-2 would be the same as for Sub-Alternative C-1. Differences in pipelines would be that the Colville River crossing near CD-4 under Sub-Alternative C-2 would be via a pipeline-only bridge. Also, because there would be no road connection between the existing Alpine Development Project and the pads west of the Colville River, a 2-inch products pipeline would be required to supply reduced sulfur diesel fuel to the drill rig until the state’s road has been completed. After the Colville River Road has been completed, diesel may be resupplied to the drill rigs by truck.

Sub-Alternative C-2 would include a modified connection to Nuiqsut, and is presented in Figure 2.4.3.2-1. The road would bypass Nuiqsut to the west. The bypass road would be sited on Kuukpik and BLM lands, and would go south and then west around Nuiqsut to tie into the proposed state Colville River Road south of Nuiqsut.

A 2-acre vehicle storage area would be constructed on a new gravel pad adjacent to the Nuiqsut bypass road. The vehicle storage area would be located near the junction of the ASDP Nuiqsut bypass road and the west end of the Colville River Road. The vehicle storage area would be developed with a vehicle storage and repair warehouse to shelter and service vehicles routinely used on the ASDP road network west of the Colville River. The vehicles could include pickup trucks, road graders, water trucks, and front-end loaders. The pad would also have cold storage and warm storage. Electrical power supplied from the Nuiqsut grid would be connected to vehicle storage area facilities. The power wires would be suspended from overhead power poles, 60 feet high and spaced 250 feet apart. The vehicle storage area would have a water storage tank and a waste accumulation tank. Water would be supplied from Nuiqsut or the Kuparuk Oilfield. Wastewater would be hauled by tank truck to existing approved treatment and disposal facilities at Nuiqsut or the Kuparuk Oilfield.

A spur road from the Colville River Road to the Nuiqsut village and airstrip is an existing component of the state’s proposed Colville River Road project. This spur road would effectively connect the ASDP road system from CD-5 to CD-7 to Nuiqsut. Existing infrastructure at Nuiqsut includes limited lodging and stores. Lodging includes the Kuukpik Hotel and Kuukpik Arctic Catering. Supply stores include Kuukpik Hardware and Kuukpik AC Store. The Nuiqsut Airport has an unattended 4,340-foot gravel runway. For comparison, the Alpine Development Project runway is a 5,000-foot gravel runway. The Nuiqsut runway is lighted and used year-round. Northern Air Cargo (NAC) flies a DC-6 chartered by the oil companies into the airstrip fairly regularly. NAC operates regularly scheduled flights to Deadhorse. When flying into Nuiqsut NAC can carry 20,000 pounds of cargo from Anchorage,24,000 pounds from Fairbanks, and 28,000 pounds from Deadhorse, NAC does not carry passengers. Other carriers are available for charter to transport passengers to Nuiqsut.

The NSB Nuiqsut Utility power plant has a generating capability of 2.7 MW. The Nuiqsut Landfill is a Class III (village), landfill authorized for disposal of septage, inert, municipal, ash, sludge, construction debris, fish waste, and animal waste. The landfill is operated by the NSB. The ADEC Wastewater Disposal Permit No. 0136-DB006 for the Nuiqsut Wastewater Treatment Plant allows disposal of a maximum of 28,000 gpd of secondary treated domestic wastewater onto the tundra. In 2002, the NSB CIP installed interior water piping and sewage connections to all buildings in Nuiqsut. Thus, it seems possible that other facilities could be hooked up to the village utilities. Nuiqsut drinking water is derived from a nearby lake then treated and stored in a holding tank. Residents also have individual water tanks with water delivery service, and use honeybuckets to dispose of sewage. Hauling services are provided. A majority of homes have running water to the kitchen.

Community plans call for the construction of a piped system with flush toilets, showers, and household plumbing.

SUB-ALTERNATIVE C-2 – QUANTITY ESTIMATES

Table 2.4.3-6 and Table 2.4.3-7 provide the estimated gravel quantities required for production pad, airstrip, and road segment construction under Sub-Alternative C-2. Annual water use for ice roads would be different than that for Sub-Alternative C-1 and are presented in Table 2.4.3-8. The difference in ice road requirements between Sub-Alternatives C-1 and C-2 is due to the construction of the gravel road connection to the proposed state road, and not having a gravel road connection across the Nigliq Channel, which necessitates annual operations ice roads. Although it is not related to or part of the ASDP project, if it is constructed in the next several years, the Colville River Road proposed by the state would eliminate the need for an annual ice road between the Kuparuk Oilfield and CD-1. Table 2.4.3-9 shows the estimated pipeline lengths and diameters associated with production pads under Sub-Alternative C-2.

Estimated vehicle traffic and aircraft flights during each of the three phases of the applicant's proposed action—construction, drilling, and operations—for Sub-Alternative C-2 are similar to Alternative A and Sub-Alternative C-1 because under the schedule proposed by the State the proposed state road connection to the Kuparuk Oilfield would not be completed until late in the construction phase (2010). Once available for use by industry, the road connection might result in a decrease in aircraft flights into the Plan Area but an increase in vehicle traffic from the Kuparuk Oilfield; however, the total number of trips made by workers into the Plan Area would remain the same for Alternative A, Sub-Alternative C-1, and Sub-Alternative C-2. For purposes of analyses, Sub-Alternative C-2 is assumed to have the same vehicle traffic and aircraft flights as Alternative A and Sub-Alternative C-1.

Once the proposed state road to Nuiqsut is completed, industry flights into the Plan Area likely would be split between Nuiqsut and CD-1. Similarly, total road traffic would be comparable to Alternative A and Sub-Alternative C-1, but would be split between the two separate road clusters because of the lack of road connection between CD-4 and CD-5 in Sub-Alternative C-2. Workers traveling to CD-3 or CD-4 would fly into CD-1; however, nearly all construction traffic after 2010 would be in support of CD-5, CD-6, or CD-7 and would go over the Colville River Road. Construction workers would be housed either at CD-1 or Nuiqsut, as with other alternatives. Drilling crews would fly into the Kuparuk Oilfield and travel by bus to the drill sites. Operations personnel would be housed at CD-1. They would make two routine trips daily to the pads by flying from CD-1 to Nuiqsut.

SUB-ALTERNATIVE C-2 – CONSTRUCTION AND OPERATIONS SCHEDULE

The construction and operations schedule for Sub-Alternative C-2 would be the same as that for Sub-Alternative C-1, except that modules and other surface facilities at CD-5 and CD-7 and the pipeline and the powerlines and poles to be installed to connect with CD-7 in the winter of 2010 may reach the area of construction via the state road, rather than from CD-1 via the Nigliq Channel bridge. Similarly, during drilling, one drill rig may reach CD-5 or CD-7, and supplies, equipment, and personnel for drilling may reach both pads via the state road, rather than from CD-1. During operations, personnel would make their up to two routine round trips daily to the pads by flying to Nuiqsut from CD-1, where personnel, unless residents of Nuiqsut, would be housed. Heavier vehicles, such as graders and road-watering trucks, would be driven from the storage area near Nuiqsut, rather than directly from CD-1. Some repairs that would have been staged out of CD-1 could also be accomplished by transportation by the state road from the Kuparuk Oilfield. Finally, abandonment also could be accomplished on a direct road to the Dalton Highway, rather than relying on use of the road bridge across the Nigliq Channel to CD-1 and an ice road between CD-1 and the Kuparuk Oilfield.

TABLE 2.4.3-6 SUB-ALTERNATIVE C-2 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		Airstrips and Apron/Taxiways/Boat Launches		Totals	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
CD-3	78	9.1	2	0.2	80	9.3
CD-4	112	9.3	16	1.4	128	10.7
CD-5	78	9.1	0	0.0	78	9.1
CD-6	78	9.1	0	0.0	78	9.1
CD-7	78	9.1	0	0.0	78	9.1
Nuiqsut Storage Pad	16	2.0	0	0.0	16	2.0
TOTAL	**440**	**47.7**	**18**	**1.6**	**458**	**49.3**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.3-7 SUB-ALTERNATIVE C-2 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
Alpine to CD-3	6.4	264	41.9
Alpine to CD-4	3.5	210	25.3
CD-5 to CD-6, Primary Road	9.5	392	62.3
CD-6 to CD-7, Primary Road	6.0	246	39.2
CD-5 Pad Access Road	5.0	207	33.0
CD-6 Pad Access Road	4.4	181	28.8
Nuiqsut junction To State Road	4.7	193	30.4
CD-4/CD-5 junction To Nuiqsut junction	2.1	85	13.5
Total	**41.6**	**1778**	**274.4**

Notes:

32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.

Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.3-8 SUB-ALTERNATIVE C-2 – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Total Annual Ice Road (miles) and Water Usage (million gallons)
2005	61	0	61
2006	51	0	51
2007	65	7	72
2008	81	12	93
2009	65	5	70
2010	0	5	5
2011	0	0	0
TOTAL	**323**	**29**	**352**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Construction estimate includes a 28-mile annual ice road from Kuparuk to CD-1.
Estimates assume gravel supply from the ASRC Mine Site and Clover Potential Gravel Source.
Assumes ice roads annually, during construction and drilling, to all sites not connected via gravel roads.

TABLE 2.4.3-9 SUB-ALTERNATIVE C-2 – APPROXIMATE LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	A	624
CD-1 to CD-4	4.5	B	432
CD-5 to CD-5 tie-in	4.9	A	470
CD-5 tie-in to CD-1/4	4.4	B	422
CD-6/CD-7 junction to CD-5 tie-in	11.7	B	1123
CD-6 to CD-6/CD-7 junction	4.4	B	422
CD-7 to CD-6/CD-7 junction	5.9	A	566
TOTAL	**42.3**		**4,059**

Notes:
A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.
B = Pipelines included in “A” above and 2-inch products.

2.4.3.3 Sub-Alternative C-1 – Full-Field Development Scenario

SUB-ALTERNATIVE C-1 – FFD DESCRIPTION

In the FFD scenario for Sub-Alternative C-1, roads would link all pads to processing facilities, CD-1, and Nuiqsut. Roads in the Colville River Delta also would be constructed.

Road construction could occur in the lower Colville River Delta to reach future oil production pads. The extent of such roads and the challenges they would pose are illustrated by extending roads to four HPs (HP-7, HP-12, HP-13, and HP-14) requiring multiple channel crossings. To design such roads, the design floodwater surface elevations, as discussed in Section 2.4.3, would need to be ascertained. There are very few physiographic features that remain above floodwaters, which can make siting roads difficult (PN&D 2002b).

The bridge crossing lengths required to reach the HPs in the Colville River Delta are listed in Table 2.4.3-10, based on the routes shown in Figure 2.4.3.3-1 in the same manner as previously estimated for Figure 2.4.3.1-1.

TABLE 2.4.3-10 SUB-ALTERNATIVE C-1 – ESTIMATED BRIDGE LENGTHS

Road Segment	Channels Crossed	Estimated Lengths (feet)	Segment Total (feet)
CD-1 to HP-7 (1.6 miles)	Tamayayak	1,100	1,100
HP-7 to HP-12 (6.0 miles)	unnamed Elaktoveach Elaktoveach	400 1,000 3,500	4,900
HP-12 to HP-13 (4.3 miles)	unnamed unnamed	150 800	950
HP-12 to HP-14 (5.2 miles)	unnamed Kupigruak	400 4,800	5,200

To have accessible year-round roads to the hypothetical FFD pads in the Delta, the road surfaces would be designed to be above conservative estimates of flood levels. With the use of design criteria from the *Colville River Unit Satellite Environmental Evaluation Document* (PAI 2002a), the road should be high enough to handle a 200-year flood with 1 foot of freeboard. In addition, roads on the Colville River Delta would have to accommodate storm surges that could cause the Delta to back up from elevated sea levels offshore.

A study estimating culvert needs for the National Petroleum Reserve-Alaska roads (PN&D 2002b) identified drainages from maps and photographs and sized culverts to match. It also estimated an additional 10 culverts per mile of roadway (approximately one per 500 feet of roadway) to address additional drainage issues. A road bisecting major Colville River Delta channels would require more culverts and bridges of varying sizes per mile to alleviate hydraulic forces from floodplain flow from a spring break-up/ice dam event or a mid-summer, rain-induced flood. The proposed roads would be monitored to determine if they were affecting the Colville River Delta flow regimes or causing changes to river erosion and deposition patterns.

SUB-ALTERNATIVE C-1 – FFD QUANTITY ESTIMATES

The differences between Alternative A – FFD and Sub-Alternative C-1 – FFD have been described above and can be seen by comparing Figures 2.4.1.2-1 and 2.4.3.3-1. Tables 2.4.3-11 and 2.4.3-12 present the estimated areas covered by the Sub-Alternative C-1 FFD facilities and the volume of gravel required to develop those hypothetical facilities. Table 2.4.3-13 presents estimated pipeline lengths and diameters. Table 2.4.3-14 shows the annual projected water usage for the ice roads associated with FFD Sub-Alternative C-1, assuming a hypothetical sequence of development for analysis purposes.

TABLE 2.4.3-11 SUB-ALTERNATIVE C-1 – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production Pad		Airstrip Taxiway and Access Road		Totals	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-1	78	9.1	—	—	78	9.1
HP-2	78	9.1	—	—	78	9.1
HP-3	78	9.1	—	—	78	9.1
HP-4	78	9.1	—	—	78	9.1
HP-5	78	9.1	—	—	78	9.1
HP-6	78	9.1	—	—	78	9.1
HP-7	78	9.1	—	—	78	9.1
HP-8	78	9.1	—	—	78	9.1
HP-9	78	9.1	—	—	78	9.1
HP-10	78	9.1	—	—	78	9.1
HP-11	78	9.1	—	—	78	9.1
HP-12	78	9.1	—	—	78	9.1
HP-13	78	9.1	—	—	78	9.1
HP-14	78	9.1	—	—	78	9.1
HP-15	78	9.1	—	—	78	9.1
HP-16	78	9.1	—	—	78	9.1
HP-17	78	9.1	—	—	78	9.1
HP-18	78	9.1	—	—	78	9.1
HP-19	78	9.1	—	—	78	9.1
HP-20	78	9.1	—	—	78	9.1
HP-21	78	9.1	—	—	78	9.1
HP-22	78	9.1	—	—	78	9.1
HPF-1	317	36.3	228	29.4	545	65.7
HPF-2	317	36.3	228	29.4	545	65.7
TOTAL	**2350**	**272.8**	**456**	**58.8**	**2806**	**331.6**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, aprons, and roads; 2H:1V slideslopes.

Total may not be exact because of rounding.

TABLE 2.4.3-12 SUB-ALTERNATIVE C-1 – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	Length (miles)	Gravel (1,000 cy)	Coverage (acres)
HP-1 to CD-6	4.7	193	27.9
HP-2 to CD-7	2.6	107	15.6
HP-3 to CD-5	3.8	156	22.4
HP-4 to CD-4	2.5	103	15.0
HP-5 to CD-2	3.2	132	27.8
HP-6 to Spine	1.5	62	9.0
HP-7 road to CD-3/1 road	1.5	62	8.1
HP-8 to HP-9/spine road	3.9	160	22.9
HP-9 to Spine	5.6	230	33.3
HP-10 to CD-7/HP-2 road	7.3	300	42.9
HP-11 to HP-9	8.7	358	51.3
HP-12 to HP-7	6.0	247	52.5
HP-13 to HP-12	4.3	177	38.0
HP-14 to HP-12	5.2	214	46.0
HP-15 to CD-6	10.4	427	61.3
HP-16 to HPF-1	5.6	230	33.0
HP-17 to HP-16	6.9	284	40.9
HP-18 to HPF-1	7.8	321	46.1
HP-19 to HP-17	9.0	370	53.2
HP-20 to HPF-2/HP-18 road	8.9	366	52.4
HP-21 to HPF-2	9.8	403	57.8
HP-22 to HP-21	11.0	452	96.5
HPF-1 to CD-7	5.8	238	34.5
Spine, HPF-2 to HP-18	10.7	440	63.4
TOTAL	**147.2**	**6,029**	**951.7**

Notes:
32-foot road width covers area 52 feet toe-of-slope to toe-of-slope.
Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.

TABLE 2.4.3-13 SUB-ALTERNATIVE C-1 – ESTIMATED LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
HP-1 to CD-6	4.9	A	467
HP-2 to CD-7	2.8	B	267
HP-3 to CD-5	3.8	A	365
HP-4 to CD-4	2.2	A	207
HP-5 to CD-2	3.2	A	303
HP-6 to Spine	1.5	A	144
HP-7 to CD-3/1	1.5	B	142
HP-8 to HP-9 tie-in	4.0	A	386
HP-9 to Spine	7.1	B	682
HP-10 to CD-7/HP-2	7.3	B	697
HP-11 to HP-9	8.7	A	840
HP-12 to HP-7	6.0	B	575
HP-13 to HP-12	4.2	A	402
HP-14 to HP-12	5.2	A	499
HP-15 to CD-6	10.6	A	1,016
HP-16 to HPF-1	5.4	B	523
HP-17 to HP-16	6.9	B	665
HP-18 to HPF-1	7.8	C	753
HP-19 to HP-17	9.0	A	867
HP-20 to HPF-2/HP-18	8.9	A	854
HP-21 to HPF-2	10.1	B	968
HP-22 to HP-21	11.1	A	1069
HPF-2 to HP-18	10.7	B, C	1,029
HPF-1 to CD-6/7	5.8	B, C	560
TOTAL	**148.7**		**14,278**

Notes:
A = Pipelines include 18-inch produced fluids, 8-inch gas, 10-inch water, and 6-inch lift gas.
B = Pipelines include 24-inch produced fluids, 10-inch gas, 14-inch water and 6-inch lift gas.
C = 14-inch sales oil and 12-inch seawater supply pipeline.

TABLE 2.4.3-14 SUB-ALTERNATIVE C-1 – FFD ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Construction Timeframe	Year	Facilities Constructed	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)
2011 to 2015	2011	HP-4 & HP-5	18	NA
	2012	HP-7	21	NA
	2013	HP-12	33	NA
	2014	HP-13	30	NA
	2015	HP-14	33	NA
2016 to 2018	2016	HP-1	17	NA
	2017	HP-3	12	NA
	2018	HP-15	47	NA
2019 to 2022	2019	HPF-1 & HP-2	45	NA
	2020	HP-10	33	NA
	2021	HP-16	23	NA
	2022	HP-17 & HP-19	31	NA
2023 to 2026	2023	HPF-2 & HP-18	84	NA
	2024	HP-20	21	NA
	2025	HP-21	42	NA
	2026	HP-22	49	NA
2027 to 2030	2027	HP-6	13	NA
	2028	HP-8	12	NA
	2029	HP-9	18	NA
	2030	HP-11	44	NA
TOTAL			**626**	**0**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Estimates assume gravel supply from the ASRC Mine Site, Clover Potential Gravel Source and hypothetical future gravel source(s).
Assumes ice roads annually to all sites not connected via gravel roads.

2.4.3.4 Sub-Alternative C-2 – Full-Field Development Scenario

SUB-ALTERNATIVE C-2 – FFD DESCRIPTION

Sub-Alternative C-2 – FFD, would be much the same as Sub-Alternative C-1 – FFD. All of the differences between these alternatives occur near Nuiqsut and as described above under the CPAI Development Plan. Therefore, a specific FFD scenario for Sub-Alternative C-2 has not been developed.

2.4.4 Alternative D – Roadless Development

Alternative D excludes the construction of roads for access to production pads. Access to production pads would be by fixed-wing aircraft, helicopter, ice road, or low-ground-pressure-vehicle travel on tundra. The pipeline crossing of the Nigliq Channel would be accomplished by using HDD rather than a pipeline bridge. Pipelines would be built with a minimum height of 7 feet (measured at the VSMs). Power cables would be located on VSM-mounted cable trays. Exceptions to Stipulations 39(d) and 41 of the Northeast National Petroleum Reserve-Alaska IAP/EIS ROD would be required. For the purpose of analysis, Alternative D is presented as two sub-alternatives. Sub–Alternative D-1 includes gravel airstrips and access by fixed wing aircraft and ice roads. A short airstrip access road at CD-4 requires a 40-foot vehicle bridge over the Sakoonang Channel. Sub-Alternative D-2 includes gravel helipads and year-round access by helicopters and winter access by fixed-wing aircraft to ice airstrips, and by vehicles on ice roads. All other elements are common to both sub-alternatives. Figure 2.4.4-1 presents the site map for Alternative D, and Figure 2.4.4-2 presents the site map for Alternative D-FFD.

Two-inch product pipelines would be routed, along with the other pipelines, to each production pad. Ice roads and an ice bridge across the Nigliq Channel would be constructed every winter during drilling and every few years during operations. In the summer, ground access could include the use of low-ground-pressure vehicles on the tundra, though an exception would have to be obtained for such use on BLM-managed lands.

All production pads in Alternative D would be in the same locations as in Alternative A; however, pipelines would be routed slightly differently (more directly) because there would not be roads. When roads are constructed, the pipelines are usually placed parallel to the roads for ease of inspection. This alternative would employ HDD for placement of pipelines under Nigliq Channel. Use of HDD for the Nigliq Channel crossing would entail the use of a transition cellar at each end of the crossing to pass the warm pipeline through the active layer of soil. The cellars need to be actively refrigerated to prevent non-differential settlement or movement. HDD crossings require vertical pipeline elevation changes. Elevation changes in pipelines carrying multiple phase fluids can cause slugging, a phenomenon in which denser fluid accumulates in low points until it blocks flow sufficiently to cause pressure buildup that then blows the accumulated dense fluid through the low point in a “slug” or surge. During design and installation of the pipeline, elevation changes and pipeline angles would be minimized to reduce slugging potential. However, the existence of a low point in the HDD segment can not be eliminated and would present a potential slugging problem.

2.4.4.1 Sub-Alternative D-1 – CPAI Development Plan

SUB-ALTERNATIVE D-1 – CPAI DEVELOPMENT PLAN

SUB-ALTERNATIVE D-1 – DESCRIPTION

The five satellites would be developed as stand-alone production pads with year-round, fixed-wing aircraft access. Airstrips would be built at each production pad. The only gravel road segments to be constructed would be from the airstrips to the well pad at each production pad. Well pads would be the larger approximately 11.6-acre size used for roadless pads

SUB-ALTERNATIVE D-1 – QUANTITY ESTIMATES

Table 2.4.4-1 provides the estimated gravel quantities and tundra coverage required for drill site, airstrip, and apron/taxiway construction under Sub-Alternative D-1. Table 2.4.4-2 shows the annual projected water usage for ice roads. Table 2.4.4-3 presents pipeline lengths and diameters associated with development of the applicant’s proposed five-pads under Sub-Alternative D-1. Estimated vehicle traffic and aircraft flights during each of the three phases of the applicant’s proposed action—construction, drilling, and operations—are provided in Table 2.4.4-4.

The construction and operations schedule for Sub-Alternative D-1 would be essentially the same as that for Alternative A (Table 2.4.1-6). The primary difference would be that for Alternative D-1 gravel would not be laid for roads when gravel is laid for production pads. CD-3 remains restricted to winter-only drilling, and CD-4 would retain summer-only drilling, with the rig seasonally switching between CD-3 and CD-4.

TABLE 2.4.4-1 ALTERNATIVE D-1 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		Airstrips and Apron/Taxiways/Boat Launches		Total	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
CD-3	110	12.6	144	18.0	254	30.6
CD-4	223	17.9	297	41.3	520	59.2
CD-5	149	17.6	196	24.3	345	41.9
CD-6	149	17.6	202	25.2	351	42.8
CD-7	149	17.6	227	29.2	376	46.8
TOTAL	**780**	**83.3**	**1066**	**138.0**	**1846**	**221.5**

Notes: Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.4-2 ALTERNATIVE D-1 – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Total Annual Ice Road (miles) and Water Usage (million gallons)
2005	51	0	51
2006	44	10	54
2007	55	10	65
2008	66	14	80
2009	78	25	103
2010	0	33	33
2011	0	0	0
TOTAL	**294**	**92**	**386**

Notes: Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.

Mileage estimated by straight line between locations + 25% to account for routing around land features.

Ice roads typically require 1,000,000 gallons per mile constructed.

Construction estimate includes a 28-mile annual ice road from Kuparuk to CD-1.

Estimates assume gravel supply from the ASRC Mine Site and Clover Potential Gravel Source.

Assumes ice roads annually, during construction and drilling, to all sites not connected via gravel roads.

TABLE 2.4.4-3 ALTERNATIVE D-1 – APPROXIMATE LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	B	624
CD-1 to CD-4	4.5	B	432
CD-1 to CD-5 (minus HDD)	5.6	B	538
HDD Crossing	0.6	B	NA
CD-5 to CD-6	8.6	B	826
CD-6 to CD-7	6.2	B	595
CD-5 access spur	0.3	B	29
CD-6 access spur	0.8	B	77
TOTAL	**33.1**		**3121**

Notes:

A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.

B = Pipelines included in “A” above and 2-inch products.

TABLE 2.4.4-4 ALTERNATIVE D-1 – ESTIMATED TRAFFIC

	Construction Phase		**Drilling Phase**		**Operations Phase**	
	Round-Trip Vehicle Trips per Month	**One-Way Aircraft Flights Per Month**	**Round-Trip Vehicle Trips per Month**	**One-Way Aircraft Flights Per Month**	**Round-Trip Vehicle Trips per Month**	**One-Way Aircraft Flights Per Month**
Winter 2004/2005	6,000 (18,600 max.)	70 (235 max.)	0	0	0	0
Summer 2005	0	240 (690 max.)	0	0	0	0
Winter 2005/2006	5,800 (19,800 max.)	60 (245 max.)	0	70-90	0	0
Summer 2006	0	470 (860 max.)	0	30-40	0	56
Winter 2006/2007	3,900 (12,000 max.)	70 (165 max.)	0	70-90	16	24
Summer 2007	0	290 (300 max.)	0	30-40	0	56
Winter 2007/2008	4,000 (11,700 max.)	50 (145 max.)	390-450	70-90	16	24
Summer 2008	0	770 (790 max.)	0	65-75	0	80
Winter 2008/2009	2,800 (7,500 max.)	50 (205 max.)	390-450	70-90	24	32
Summer 2009	0	0	0	30-40	0	80
Winter 2009/2010	1,000 (3,600 max.)	50	780-900	70-90	24	32
Summer 2010	0	635 (660 max.)	0	65-75	0	128
Winter 2010/2011	600 (3,300 max.)	45	780-900	70-90	24	48

Source: CPAI 2003l

Notes:

Aircraft flights to pads are by helicopter.

Fixed Wing Aircraft flights include flights from Kuparuk to Alpine.

Each construction and drilling related flight assumed to equal 12 vehicle trips.

Operations phase flights assumed to equal four vehicle trips.

Excludes non-operational helicopter flights estimated at 2500 per summer season .

For the purposes of this table, seasons have been defined to correspond to periods when wildlife and bird populations are prevalent in the Plan Area, i.e., Summer = May through September, and Winter = October through April. These seasonal designations do not correspond with periods of ice road travel, for which winter would be defined as December through April.

2.4.4.2 Sub-Alternative D-2 – CPAI Development Plan

Sub-Alternative D-2 is similar to Sub-Alternative D-1 with respect to following the theme of roadless access to production pads. The difference is that access would be by helicopter rather than by fixed-wing aircraft. Helicopters would provide the only means of access during the summer. Ice roads could be constructed for vehicle access during the winter months, as in Sub-Alternative D-1.

Helipads would be constructed of gravel fill near each production pad. Each helipad would have a top surface area of approximately 1 acre. Production pads would be the larger; 11.6-acre size used for roadless pads, plus the additional acres for the helipad. Helipad gravel thickness would be an average of 5 feet, except at CD-3, where average thickness would be 14 feet.

Bell 212, 214, or equivalent twin-engine helicopters would be based at the Alpine Development Project (CD-1), and would transport workers, supplies, and equipment from there to the production pads.

Access to production pads only by helicopter during the summer months presents an additional challenge for a year-round drilling program. Provision to bring an emergency drill rig to a production pad for relief-well construction in case of well blow-out during drilling is a standard safety requirement. Currently, helicopters that are capable of transporting an emergency drill rig are not based on the North Slope. Implementation of Sub-alternative D-2 would require the availability of a helicopter capable of transporting an emergency drill rig during summer and delivering a relief rig to a production pad in winter. The drill rig would be left stranded to be available for relief during summer drilling or restriction to a winter-only drilling schedule. During winter, an emergency drill rig could be brought to production pads via ice roads or ice airstrips. Sub-Alternative D-2 adopts the winter-only drilling scenario. This results in an extended development schedule compared to Alternative A. This extended schedule could be accelerated by mobilizing more than one drilling rig or by stationing a relief rig at the drilling site to allow year-round drilling.

Table 2.4.4-5 provides the estimated gravel quantities required for drill site and helipad under Sub-Alternative D-2. Annual water use for ice roads is presented in Table 2.4.4-6 The pipeline lengths and diameters associated with Sub-Alternative D-2 would be the same as for Sub-Alternative D-1 (Table 2.4.4-3). Estimated aircraft flights during each of the three phases of the applicant's proposed action—construction, drilling, and operations—are provided in Table 2.4.4-7.

The construction and operations schedule for Sub-Alternative D-2 is prolonged compared to that for Alternative A (Table 2.4.1-5). The primary difference would be that for Sub-Alternative D-2, gravel would not be laid for roads or airstrips when gravel is laid for production pads. All vehicle travel would be limited to ice roads in winter. Drilling at all production pads would be restricted to winter-only drilling. Assuming a one-rig program, 20 wells per production pad, and three wells per year per rig, drilling at CD-3 would take 7 years, before drilling at CD-4 began, and a total of approximately 33 years of drilling for the five-pad ASDP.

TABLE 2.4.4-5 ALTERNATIVE D-2 – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		**Helipad**		**Total**	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
CD-3	110	12.6	12	1.4	122	14.0
CD-4	165	12.9	26	2.7	191	15.6
CD-5	110	12.6	10	1.3	120	13.9
CD-6	110	12.6	10	1.3	120	13.9
CD-7	110	12.6	10	1.3	120	13.9
TOTAL	605	63.3	68	8.0	673	71.3

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.

Total may not be exact because of rounding.

Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.4-6 ALTERNATIVE D-2 – ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Construction Timeframe	Year	Facilities Constructed	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Drilling and Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Annual Total Ice Road (miles) and Water Usage (million gallons)
2005 to 2010	2005	CD-3	55	0	55
	2006	CD-3	0	10	10
	2007	CD-3	0	10	10
	2008	CD-3	0	10	10
	2009	CD-3	0	10	10
	2010	CD-3	0	10	10
2011 to 2015	2011	CD-3, CD-4	44	10	54
	2012	CD-3, CD-4	0	15	15
	2013	CD-4	0	15	15
	2014	CD-4	0	15	15
	2015	CD-4	0	15	15
2016 to 2018	2016	CD-4	0	15	15
	2017	CD-4, CD-6	67	15	82
	2018	CD-4, CD-6	0	31	31
2019 to 2022	2019	CD-6	0	31	31
	2020	CD-6	0	31	31
	2021	CD-6	0	31	31
	2022	CD-6	0	31	31
2023 to 2026	2023	CD-6, CD-5	40	27	67
	2024	CD-6, CD-5	0	31	31
	2025	CD-5	0	31	31
	2026	CD-5	0	31	31
2027 to 2030	2027	CD-5	0	31	31
	2028	CD-5	0	31	31
	2029	CD-5, CD-7	56	31	87
	2030	CD-5, CD-7	0	39	39
		TOTAL	**262**	**557**	**819**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Construction estimate includes a 28-mile annual ice road from Kuparuk to CD-1.
Estimates assume gravel supply from the ASRC Mine Site and Clover Potential Gravel Source.
Assumes single drill rig, winter-only drilling.

TABLE 2.4.4-7 ALTERNATIVE D-2 – ESTIMATED TRAFFIC

	Construction Phase			**Drilling Phase**			**Operations Phase**		
	RT-V[1]	**RT-H[2]**	**OW-F[3]**	**RT-V**	**RT-H**	**OW-F**	**RT-V**	**RT-H**	**OW-F**
Winter 2004/2005	6,000 (14,600 max.)	36 (183 max.)	70 (235 max.)	0		0	0	0	0
Summer 2005	0	65 (305 max.)	180 (500 max.)	0		0	0	0	0
Winter 2005/2006				390-450	38	13-26	0	0	0
Summer 2006	0			0	134	0	0	85	0
Winter 2006/2007				390-450	34	13-26	32	84	0
Summer 2007	0		0	0	85	0	0	14	0
Winter 2007/2008				390-450	34	13-26	32	36	0
Summer 2008	0			0	85	0	0	14	0
Winter 2008/2009				390-450	34	13-26	48	36	0
Summer 2009	0		0	0	85	0	0	14	0
Winter 2009/2010			0	390-450	34	13-26	48	36	0
Summer 2010	0			0	80	13-26	0	84	0
Winter 2010/2011	600 (3300 max.)	36	70 (200 max.)	390-450	34	13-26	80	36	0

Source: CPAI 2003l

Notes: Under the construction phase, the first number is the average; the numbers in parentheses represent the range.

[2] Round-Trip Vehicle Trips per month.

[3] Round Trips-Helicopter flights per month.

[4] One-Way Flights-Fixed Wing Aircraft flights per month, reflects flights in from Kuparuk to Alpine.

For the purposes of this table, seasons have been defined to correspond to periods when wildlife and bird populations are prevalent in the Plan Area, i.e., Summer = May through September, and Winter = October through April. These seasonal designations do not correspond with periods of ice road travel, for which winter would be defined as December through April.

2.4.4.3 Sub-Alternative D-1 – Full-Field Development Scenario

SUB-ALTERNATIVE D-1 – FFD DESCRIPTION

The FFD for Sub-Alternative D-1 differs from that for Alternative A primarily by excluding all roads, except short ones between production pads and nearby airstrips. Thus, all production pads would require gravel fill airstrips, ice roads, or ice airstrips. The Alternative D – FFD scenario involves construction of the same number of production pads and HPFs, and in the same locations, as described for Alternative A. Each production pad would be slightly larger than the road-supported production pads in Alternative A – FFD to allow for additional space for seasonal equipment and materials staging. Pipeline alignments for Sub-Alternative D-1 are slightly shorter and more direct than in Alternative A because they do not follow road alignments. A 2-inch products pipeline would supply each production pad. The production pads would be served by seasonal ice roads to support development drilling and construction activities. Ice airstrips and ice storage pads also could be used to support drilling, construction, or operations.

SUB-ALTERNATIVE D-1 – FFD QUANTITY ESTIMATES

The differences between Alternative A – FFD and Sub-Alternative D-1 – FFD have been described above and can be seen by comparing Figures 2.4.1.2-1 and 2.4.4-2. Table 2.4.4.8-presents the areas covered by the Alternative D – FFD facilities and the volume of gravel required to develop those hypothetical facilities. Table 2.4.4-9 presents the length and diameter of the pipelines. Table 2.4.4-10 presents the miles of ice roads and associated water requirements, assuming a hypothetical sequence of development for analysis purposes.

TABLE 2.4.4-8 ALTERNATIVE D-1 – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	PRODUCTION PAD		AIRSTRIP AND APRON/TAXIWAY		TOTAL	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-1	149	17.6	228	29.4	377	47.0
HP-2	149	17.6	228	29.4	377	47.0
HP-3	149	17.6	228	29.4	377	47.0
HP-4	149	17.6	228	29.4	377	47.0
HP-5	110	12.6	228	29.4	338	42.0
HP-6	149	17.6	228	29.4	377	47.0
HP-7	110	12.6	162	21.5	272	34.1
HP-8	149	17.6	228	29.4	377	47.0
HP-9	149	17.6	228	29.4	377	47.0
HP-10	149	17.6	228	29.4	377	47.0
HP-11	149	17.6	228	29.4	377	47.0
HP-12	110	12.6	162	21.5	272	34.1
HP-13	110	12.6	162	21.5	272	34.1
HP-14	110	12.6	162	21.5	272	34.1
HP-15	149	17.6	228	29.4	377	47.0
HP-16	149	17.6	228	29.4	377	47.0
HP-17	149	17.6	228	29.4	377	47.0
HP-18	149	17.6	228	29.4	377	47.0
HP-19	149	17.6	228	29.4	377	47.0
HP-20	149	17.6	228	29.4	377	47.0
HP-21	149	17.6	228	29.4	377	47.0
HP-22	149	17.6	162	21.5	311	39.1
HPF-1	317	36.3	228	29.4	545	65.7
HPF-2	317	36.3	228	29.4	545	65.7
TOTAL	**3717**	**434.8**	**5142**	**666.1**	**8859**	**1100.9**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, aprons, and roads; 2H:1V slideslopes.

Total may not be exact because of rounding.

TABLE 2.4.4-9 ALTERNATIVE D-1 – APPROXIMATE LENGTH AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
HP-1 to CD-6/5 line	2.1	A	199
HP-2 t0 CD-7	2.8	B	267
HP-3 to CD-6/5 line	3.8	A	363
HP-4 to CD-4	2.2	A	215
HP-5 to CD-2	3.2	A	303
HP-6 to CD-5/6	5.6	B	534
HP-7 to CD-3/1 pipeline	1.5	B	143
HP-8 to HP-6/HP-9	3.9	A	375
HP-9 to HP-6	7.2	B	688
HP-10 to CD-7/HP-2 line	7.3	A	697
HP-11 to HP-9	8.7	A	840
HP-12 to HP-7	6.0	B	575
HP-13 to HP-12	4.3	A	412
HP-14 to HP-12	5.2	A	503
HP-15 to CD-6	10.6	A	1,016
HP-16 to HPF-1	5.5	B	523
HP-17 to HP-16	6.8	B	653
HP-18 to HPF-1	7.8	C	753
HP-19 to HP-17	9.0	A	860
HP-20 to HPF-2/HP-18	8.9	A	854
HP-21 to HPF-2	9.8	B	938
HP-22 to HP-21	11.2	A	1,071
HPF-2 to HP-18	10.7	B, C	1,029
HPF-1 to CD-6/7	6.2	B, C	594
TOTAL	**150.1**		**14,405**

Notes:
A = Pipelines include 18-inch produced fluids, 8-inch gas, 10-inch water, 6-inch lift gas and 2-inch products.
B = Pipelines include 24-inch produced fluids, 10-inch gas, 14-inch water, 6-inch lift gas and 2-inch products.
C = 14-inch sales oil and 12-inch seawater supply pipeline.

TABLE 2.4.4-10 ALTERNATIVE D-1 – FFD ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Construction Timeframe	Year	Facilities Constructed	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Annual Total Ice Road (miles) and Water Usage (million gallons)
2011 to 2015	2011	HP-4 & HP-5	22	33	55
	2012	HP-7	12	37	49
	2013	HP-12	13	44	57
	2014	HP-13	14	49	63
	2015	HP-14	16	55	71
2016 to 2018	2016	HP-1	10	61	71
	2017	HP-3	15	62	77
	2018	HP-15	25	66	91
2019 to 2022	2019	HPF-1 & HP-2	26	76	102
	2020	HP-10	27	80	107
	2021	HP-16	24	88	112
	2022	HP-17 & HP-19	40	94	134
2023 to 2026	2023	HPF-2 & HP-18	56	111	167
	2024	HP-20	31	131	162
	2025	HP-21	41	142	183
	2026	HP-22	48	153	201
2027 to 2030	2027	HP-6	21	166	187
	2028	HP-8	20	172	192
	2029	HP-9	18	179	197
	2030	HP-11	31	185	216
TOTAL			**510**	**1984**	**2494**

Notes:
Estimated based on sequential pad construction, utilizing constructed gravel roads to minimize ice road needs.
Mileage estimated by straight line between locations + 25% to account for routing around land features.
Ice roads typically require 1,000,000 gallons per mile constructed.
Estimates assume gravel supply from the ASRC Mine Site, Clover Potential Gravel Source and hypothetical future gravel source(s).
Assumes ice roads annually to all sites not connected via gravel roads.

The construction and operations schedule for Sub-Alternative D-1 – FFD would be essentially the same as that for Alternative A – FFD (Table 2.4.1-5). The primary difference would be that for Sub-Alternative D-1 – FFD, gravel would not be laid for roads when gravel is laid for production pads. CD-3, other production pads in the lower Delta, and CD-2 remain restricted to winter-only drilling, and CD-4 would retain summer-only drilling, with the drill rig seasonally switching between CD-3 and CD-4.

2.4.4.4 Sub-Alternative D-2 – Full-Field Development Scenario

SUB-ALTERNATIVE D-2 – FFD DESCRIPTION

Under Sub-Alternative D-2 – FFD, production pads would be accessed by helicopter instead of fixed-wing aircraft. Fixed-wing aircraft may be used during winter when ice airstrips could be built. Other facilities and operations would be the same as those described for Sub-Alternative D-1 – FFD. Helipads would be constructed of gravel fill adjacent to each production pad. Each helipad would provide approximately 1 acre of surface area for operations. Bell 212, 214, or equivalent twin-engine helicopters would be based at production pads and would transport workers, supplies, and equipment to the production pads.

As with Sub-Alternative D-2 – CPAI Development Plan, Sub-Alternative D-2 – FFD is based on an assumed winter-only drilling at all production pads.

SUB-ALTERNATIVE D-2 – FFD QUANTITY ESTIMATES

Table 2.4.4-11 presents the areas covered by the hypothetical Sub-Alternative D-2 – FFD facilities and the volume of gravel required to develop those hypothetical facilities. Sub-Alternative D-2 – FFD would be developed with the same pipeline lengths, diameters, and number of VSMs as Sub-Alternatives D-1 – FFD.

The construction and operations schedule for Alternative D-2 – FFD is analyzed based on winter-only drilling. The resulting schedule is substantially longer than that for Alternatives A through D –FFD. This extended schedule could be accelerated by using a two- or three-rig drilling program. Winter-only drilling limits a single drill rig to approximately 3 wells per year, or 7 years for a 20-well production pad. Development of the proposed five pads would require approximately 33 years. For FFD, all construction and operational activities would remain in the same season as the five-pad development, but would spread out across more years. The extended schedule would result in lower quantities of per season construction, as well as drilling workers, traffic, and water for ice roads, but would continue for as many as 100 years**.**

TABLE 2.4.4-11 ALTERNATIVE D-2 – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production Pad		Helipad		Total	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-1	120	13.9			120	13.9
HP-2	120	13.9			120	13.9
HP-3	120	13.9			120	13.9
HP-4	120	13.9			120	13.9
HP-5	120	13.9			120	13.9
HP-6	120	13.9			120	13.9
HP-7	120	13.9	162	21.5	282	35.4
HP-8	120	13.9			120	13.9
HP-9	120	13.9			120	13.9
HP-10	120	13.9			120	13.9
HP-11	120	13.9			120	13.9
HP-12	120	13.9	162	21.5	282	35.4
HP-13	120	13.9	162	21.5	282	35.4
HP-14	120	13.9	162	21.5	282	35.4
HP-15	120	13.9			120	13.9
HP-16	120	13.9			120	13.9

TABLE 2.4.4-11 ALTERNATIVE D-2 – FFD APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS (CONT'D)

	Production Pad		Helipad		Total	
Site	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**	**Gravel Qty (1,000 cy)**	**Coverage (acres)**
HP-17	120	13.9			120	13.9
HP-18	120	13.9			120	13.9
HP-19	120	13.9			120	13.9
HP-20	120	13.9			120	13.9
HP-21	120	13.9			120	13.9
HP-22	120	13.9	162	21.5	282	35.4
HPF-1	317	36.3	228	29.4	545	65.7
HPF-2	317	36.3	228	29.4	545	65.7
TOTAL	**3274**	**378.4**	**1266**	**166.3**	**4540**	**544.7**

Notes:

Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, aprons, and roads; 2H:1V slideslopes.

Total may not be exact because of rounding.

2.4.5 Alternative E – No Action

Under this alternative, CPAI would not be authorized to develop the five oil accumulations for which it currently seeks authorization. No oil in the Plan Area, except that extracted through the existing APF, would be produced in the near future, and no new roads, airstrips, pipelines, or other oil facilities would be constructed beyond what is authorized in connection with CPAI's current development at CD-1 and CD-2. The current applicant or other leaseholders may submit applications for development. However, the applicant owns a substantial portion of the leases in the area and presumably has applied to develop those that are the most readily developable.

2.4.6 Alternative F – Preferred Alternative

Alternative F – Preferred Alternative is a variation of Alternative A and includes some components from each of the action alternatives in the DEIS. It is the same as Alternative A, except for changes described below, which reflect consideration of public and agency comments, regulatory needs, and further mitigation of environmental concerns. Construction of Alternative F would be on the same schedule and would use the same means as for Alternative A. Five production pads, CD-3 through CD-7, would be built and produced fluids would be transported by pipeline to be processed at APF-1. Gravel roads would connect CD-4 through CD-7 to APF-1. CD-3 would be accessed by ice road or by air. Gravel used for construction of roads, pads, and airstrips would be obtained from the existing ASRC Mine Site and Clover. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. CD-3 would be the only new pad with an airstrip. Aboveground pipelines would be supported on VSMs and would be at elevations of at least 7 feet above the tundra, as measured at VSMs. All powerlines would be supported by cable trays placed on the pipeline VSMs. Details of variations from Alternative A are described in the subsections below.

CD-6 would be within a 3-mile setback from Fish Creek in which the BLM's Northeast National Petroleum Reserve-Alaska IAP/EIS ROD (BLM and MMS 1998b) (Stipulation 39[d]) prohibits permanent oil facilities. This alternative would provide for an exception to this stipulation to allow location of CD-6 and its associated road, pipeline spurs, and generator within the setback. As with Alternative A, additional exceptions would be required to locate oil infrastructure within 500 feet of some water bodies (Stipulation 41) and to locate roads between separate oilfields (Stipulation 48). Factors that the BLM will consider before determining to grant exceptions to these stipulations are discussed at the end of Section 2.4.6. As with Alternative A, if the first sentence of Stipulation 48 is determined to apply to the applicant’s proposed action (i.e., if, contrary to BLM’s interpretation, it is determined that the road between CD-1 and CD-2 or the additional road to CD-4 constitutes a connection to a “road system” outside the Northeast National Petroleum Reserve-Alaska planning area), the BLM would modify Stipulation 48 to allow the road from public land to connect to the existing road at APF. Finally, the USACE would have to determine that the applicant's proposed alternative for the road to CD-4 meets the intent of Special Condition 10 of its 1998 permit that authorized the placement of fill associated with the construction of the Alpine Development Project. Special Condition 10 required roadless development in the Delta unless an environmentally preferable alternative is available or roadless development is infeasible, and any alternative dependent on roads must be approved by the USACE as preferable to a roadless alternative.

2.4.6.1 Alternative F – Roads

All roads would be designed and constructed to provide adequate cross flow to prevent raising the water level on the upstream side of roads by more than 6 inches compared to that for the downstream side of the roads for more than 1 week after peak discharge.

Roads under Alternative F would be realigned compared to those proposed by CPAI (Figure 2.4.6-1). The road from CD-1 to CD-4 would be designed to meet the above cross-flow criteria and the state’s fish passage criteria (AS 41.14.840) that requires that the fish passage way would be “kept open, unobstructed, and supplied with a sufficient quantity of water to admit freely the passage of fish through it.” This requirement may be achieved by culverts crossing a narrow section of Lake 9323 as proposed in Alternative A, a bridge across the same narrow section of the lake as proposed in Alternatives B and C, or realignment of the road to the east of the lake furnished with either culverts or bridges at two water passages along its route. This alternative includes analysis of the realigned route with bridges of approximately 40 feet in length (25-foot channel opening) over the two waterways. Such a road from CD-1 to CD-4 would follow the proposed alignment in Alternative A from CD-1 to a point north of Lake 9323. This road realignment addresses concerns about the hydrology, sedimentation, and aquatic habitat of Lake 9323.

The road segment from CD-2 to CD-5 would be the same as proposed under Alternative A. The western portion of the road segment from CD-5 to CD-6 would diverge from the route in Alternative A to lessen the encroachment on the 3-mile setback from Fish Creek. The spur road to CD-6 would be extended and realigned as shown in Figure 2.4.6-1 as part of the CD-6 to CD-7 road realignment. This spur road would be located within the Fish Creek setback, a necessary condition to provide access to the CD-6 location. The road between CD-6 and CD-7 under the Preferred Alternative removes substantial infrastructure from the Fish Creek 3-mile setback. The realignment of the much of the road between CD-5 and CD-7 addresses the concern of the BLM and the public’s about encroachment of permanent oil and gas facilities in the 3-mile setback from Fish Creek.

Industry, government agencies, and local residents would be allowed access to the gravel roads.

2.4.6.2 Alternative F – Pipelines

Pipelines would be as proposed by CPAI and presented under Alternative A, except for the following changes. The pipeline alignment from CD-5 to CD-6 would be adjusted slightly so that less of it remains within the Fish Creek setback. A spur off the primary pipeline alignment would enter the Fish Creek setback near CD-6, and would connect to CD-6. The primary pipeline corridor would continue, outside of the Fish Creek setback, from the CD-6 spur to CD-7. Alternative F and associated pipeline alignments are presented in Figure 2.4.6-1. The lengths of the various pipeline segments in Alternative F are presented in Table 2.4.6-1.

TABLE 2.4.6-1 ALTERNATIVE F – LENGTHS AND DIAMETERS OF PIPELINES

Pipeline Segment	Length (miles)	Pipeline Cross Section	Number of VSMs
CD-1 to CD-3	6.5	B	624
CD-1 to CD-4	4.5	A	432
CD-1 to CD-2	2.4	A	230
CD-2 to CD-6 junction	15.2	A	1459
CD-6 access spur	2.1	A	202
CD-6 junction to CD-7	6.4	A	614
TOTAL	**37.1**		**3561**

Notes:
A = Pipelines include 16- to 24-inch produced fluids, 6- to 10-inch MI, 8- to 14-inch water, 6-inch lift gas.
B = Pipelines included in “A” above and 2-inch products.

All pipelines would be elevated relative to the proposed pipelines in Alternative A. Under Alternative F; pipelines would be 7 feet above the tundra, as measured at the VSMs. This use of elevated pipelines addresses concerns that lower pipelines can hinder caribou and, during times of drifting snow, human movement.

2.4.6.3 Alternative F – Production Pads

Production pads would be in the same locations, and built to the same design criteria, as the production pads proposed by CPAI and presented under Alternative A. These locations allow the most efficient production of the hydrocarbon resources in these reservoirs.

2.4.6.4 Alternative F – Ice Roads

Annual ice road requirements for the Preferred Alternative would be the same as those for the applicant’s proposed action presented under Alternative A and presented in Table 2.4.6-2.

TABLE 2.4.6-2 ALTERNATIVE F-ANNUAL PROJECTED WATER USAGE FOR ICE ROADS

Year	Construction – Annual Ice Road (miles) and Water Usage (million gallons)	Operations – Annual Ice Road (miles) and Water Usage (million gallons)	Annual Total Ice Road (miles) and Water Usage (million gallons)
2005	47	0	47
2006	34	10	44
2007	70	14	84
2008	34	10	44
2009	47	10	57
2010	19	10	29
2011	0	10	10
TOTAL	**251**	**64**	**315**

Source: CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

2.4.6.5 Alternative F – Bridges and Culverts

The Preferred Alternative provides for bridges that cross the Nigliq Channel and the Ublutuoch River, that span the active flow-way, and frequently active floodplain that occupies the area between topographic rises. This area, defined as “bank to bank”, is approximately 1,650 feet for the Nigliq Channel, and 350 feet for the Ublutuoch River. The resultant Nigliq Channel and Ublutuoch River bridges are longer than the bridges proposed in Alternative A., Those bridges may be relocated closer to the proposed crossings where the floodplain span is less. This EIS analyzes the longer bridges over the Nigliq Channel and the Ublutuoch River crossing at the same location as in Alternative A. The Preferred Alternative offers several options for road location and the use of bridges or culverts to meet water flow and fish passage criteria in providing for access to CD-4. (See the discussion of roads above.) This EIS analyzes a road route to the east of Lake 9323 with the use of bridges approximately 40 feet in length (25-foot channel openings) over two waterways (Figure 2.3.9.1-6).

The road and pipeline bridge across the Ublutuoch River would extend from bank to bank. The bridge, as proposed under Alternative A, is depicted in Figure 2.4.1.1-15. Figure 2.4.6-2 indicates the top of the natural bank. This would require moving the bridge to a narrower part of the channel or lengthening the bridge at its current location as measured from abutment to abutment from approximately 120 feet to approximately 350 feet. A 350-foot bridge at the same location is depicted in Figure 2.4.6-2. This bridge concept addresses concerns that the eastern abutment was within the 1-year flood level and the western abutment was in the 2-year flood level, which would regularly cause changes in stream hydrology and aquatic habitat. Culverts or minor bridges would be required at smaller water crossings. Culverts would be installed when the road is constructed. Additional culverts would be installed after break-up if ponding occurs near the road.

The road and pipeline bridge across the Nigliq Channel would extend from bank to bank. The bridge as proposed under Alternative A is depicted in Figure 2.4.1.1-14. Figure 2.4.6-3 indicates the top of the natural bank. Extending the bridge from bank to bank would require moving the bridge to a narrower part of the channel or lengthening the bridge at its current location. As measured from abutment to abutment, the bridge length at the current location would increase from approximately 1,200 feet to approximately 1,650 feet. A 1,650-foot bridge at the same location is depicted in Figure 2.4.6-3. This bridge concept addresses concerns that the eastern abutment was within the 1-year flood level and the western abutment was in the 2-year flood level, which would regularly cause changes in stream hydrology and aquatic habitat.

In addition to requiring the Nigliq Channel and Ublutuoch River bridges to extend from bank to bank, the Preferred Alternative also requires that approaches to both the Nigliq Channel and Ublutuoch River bridges provide for natural water flow. The bridge approach designs must demonstrate that cross flow will be adequate to prevent raising the water level on the upstream side of structures by more than 6 inches compared to that for downstream of the structure for more than 1week after peak discharge. The bridge approach designs must also provide assurance that the bridge approach will remain sound and not be washed out at all flow levels.

2.4.6.6 Alternative F – Utilities

The Preferred Alternative provides for all power and other cables to be routed on cable trays mounted on the pipeline VSMs. The applicant’s proposed action presented under Alternative A included power poles between CD-6 and CD-7. This change removes substantial infrastructure from the Fish Creek 3-mile setback. This measure addresses the concern of the BLM and the public about Stipulation 39 of the Northeast National Petroleum Reserve-Alaska ROD for setback from Fish Creek, which forbids permanent oil and gas facilities in the 3-mile setback.

The Preferred Alternative retains the power generating capacity at CD-6 for CD-6 and CD-7, as proposed by CPAI under Alternative A, because CD-6 would be constructed before CD-7 and would require power before CD-7 is completed. The power would be generated by a 2.7- to 3.1-MW natural gas generator (email B St. Pierre, CPAI, to J Ducker, BLM; 3-30-04).

The Preferred Alternative would require control of artificial exterior lighting on structures over 20 feet tall. Except for required safety lighting (FAA and OSHA), illumination of taller structures would be designed to direct artificial exterior lighting inward and downward, rather than upward and outward. All drilling structures, production pads, or other structures that exceed 20 feet would be illuminated in this manner.

2.4.6.7 Alternative F – Quantity Estimates

Primary access to the five proposed production pads would be by a combination of air support and gravel roads. Table 2.4.6-3 provides the estimated gravel quantities required for production pad construction under

Alternative F and also provides estimates of road mileage and yards of gravel required for construction of road segments connecting the proposed production pads and existing Alpine Development Project. Table 2.4.6-4 shows estimated gravel quantities required for road segments associated with the ASDP under Alternative F. Estimated vehicle traffic and aircraft flights during each of the three phases of the applicant's proposed action—construction, drilling, and operations—would be the same as estimated for Alternative A and are provided in Table 2.3.10-1.

TABLE 2.4.6-3 ALTERNATIVE F – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH PRODUCTION PADS

	Production and Storage Pads		**Airstrips and Apron/Taxiways/Boat Launches**		**Totals**	
Site	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**	**Gravel Qty (1,000 cy)**	**Coverage (Acres)**
CD-3	110	12.6	144	18.0	254	30.6
CD-4	112	9.3	16	1.4	128	10.7
CD-5	78	9.1	0	0.0	78	9.1
CD-6	78	9.1	0	0.0	78	9.1
CD-7	78	9.1	0	0.0	78	9.1
Total	**456**	**49.2**	**160**	**19.4**	**616**	**68.6**

Notes:
Gravel volume assumes 5.5-foot average thickness for production pads; 5-foot average thickness for airstrips, apron/taxiways and roads, except at CD-4 which has a 7.5-foot thick production pad; 2H:1V slideslopes.
Total may not be exact because of rounding.
Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

TABLE 2.4.6-4 ALTERNATIVE F – APPROXIMATE GRAVEL QUANTITIES AND COVERAGE ASSOCIATED WITH ROAD SEGMENTS

Road Segments	**Length (miles)**	**Gravel (1,000 cy)**	**Coverage (acres)**
CD-1 to CD-4	3.8	224	26.8
CD-2 to CD-6 junction	15.2	787	99.6
CD-5 access spur	0.1	5	0.6
CD-6 access spur	2.1	88	13.9
CD-6 junction to CD-7	6.3	261	41.5
TOTAL	**27.5**	**1,365**	**182.4**

Notes:
32-foot road width covers area 52-feet wide.
Gravel volume calculation assumes 5-foot average thickness, 2H:1V slideslope.
Coverage and quantity based on CPAI Permit Application (CPAI 2004a) data and calculations using GIS measurements.

2.4.6.8 Alternative F – Construction and Operations Schedule

The construction, start-up, and operations schedule for Alternative F would be the same as that proposed by CPAI under Alternative A.

FACTORS CONSIDERED FOR EXCEPTIONS TO BLM STIPULATIONS

The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations are presented in Appendix D. CPAI has asked that exceptions be granted for their project to three stipulations. Exceptions may be granted under the stipulation exeption clause, which reads:

> Exception Clause: In the event that an exception to a lease or permit stipulation is requested and before an exception may be granted, the AO shall find that implementation of the stipulation is:
>
> 1. a. technically not feasible, or
>
>   b. economically prohibitive, or
>
>   c. an environmentally preferable alternative is available, and
>
> 2. the alternative means proposed by the leassee fully satisfies the objective(s) of the stipulation.

In additional, prior to the consideration or granting of an exception to a lease or permit stipulation, all conditions and/or consultation requirements specific to a stipulation must be met. The AO shall consult with appropriate federal, state, and NSB regulatory and resource agencies before an exception may be granted, except in the case of an emergency. The AO's power to grant stipulation exceptions is limitied to those subjects, uses, and permits over which the BLM has authority. Exceptions may be granted in emergencies involving human health and safety.

STIPULATION 39

Stipulation 39 of the Northeast National Petroleum Reserve-Alaska IAP/EIS states:

> Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within and adjacent to the waterbodies listed below at the distances identified to protect fish and raptor habitat, cultural and paleontological resources, and subsistence and other resource values. Setbacks include the bed of the waterbody and are measured from the bank's highest high water mark.

The stipulation designates a 3-mile setback from Fish Creek downstream from Section 31, T11N, R1E, and a ½-mile setback farther upstream. The setback from Fish Creek was designated for "fish and subsistence resources."

The Preferred Alternative removes substantial infrastructure that was included in the applicant's proposed action from within the Fish Creek setback, but retains CD-6 within the setback based on technical, economic, and environmental factors. Drilling many wells from a single pad entails use of directional drilling. Drilling from outside the setback would require drilling long distances through geologically unstable shale. This drilling approach is very problematic because shale in this area tends to collapse holes. Maintaining drill holes would be difficult and expensive. (CPAI estimates the additional directional drilling costs at $35 million to $45 million.) In addition, the BLM estimates that 10 to 30 percent of the reserves reachable from CD-6, located where proposed by CPAI, would not be recoverable from the south side of the setback, further undermining the economic viability of placing the pad outside the setback. Placing a second pad on the north side of the Fish Creek setback to attempt to reach the 10 to 30 percent of the reserve unreachable from the south side of the setback would not only dramatically increase costs (thus undermining the economics of the applicant's proposed action), but would entail increased environmental impacts through construction of a second pad, a pipeline crossing of Fish Creek either on BLM-managed lands in the 3-mile Fish Creek setback or on Kuukpik Corporation lands in the Fish Creek delta, and either a road paralleling the pipeline or air access over Fish Creek.

The Preferred Alternative relocates substantial portions of the road and pipeline between CD-5 and CD-6 and nearly all of the road and pipeline between CD-6 and CD-7 to greatly reduce the permanent oilfield infrastructure in the 3-mile setback. However, the Preferred Alternative leaves some infrastructure in the setback based on environmental factors. Moist Tussock Tundra and Moist Sedge-Shrub Meadow habitats exist between CD-2 and CD-7. These habitats are the preferred types for road construction for the Plan Area. These are relatively high and dry habitat areas compared to other habitat. They are less prone to flooding and the resultant impacts, and they are less important habitat for waterbirds. The road proposed under the Preferred Alternative utilizes these habitats. A route utilizing these habitats is available just south of the setback for the western portion of the road on BLM-managed lands. Several large closely spaced lakes both east and west of the Ublutuoch River constrict road building immediately south of the eastern portion of the 3-mile setback. Much of the land near these lakes is low and wet. Utilization of Moist Tussock Tundra and Moist Sedge-Shrub Meadow habitat for roads would require relocating the road approximately 5 miles south of the Preferred Alternative route. This relocation would require approximately 10 more miles of roads and the resultant environmental impacts associated with habitat destruction or alteration through mining and gravel road construction. The pipeline could be moved outside the setback without incurring the same ground-disturbing impacts to sensitive habitats as placement of gravel roads. However, separating the pipeline from the road by 1 to 2 miles (and in some places separating them with a lake) complicates spill response and would likely incur additional environmental impacts in the event of a spill. Therefore, leaving the eastern portion of the road on BLM-managed land in the 3-mile setback as delineated in the Preferred Alternative is environmentally preferable to moving the road outside the setback.

The setback for permanent oil and gas facilities from Fish Creek was established to minimize impacts to “fish and subsistence resources.” The location of CD-6 and its associated road and pipeline approximately 2 miles from Fish Creek are not anticipated to have adverse impacts to fish. Although locating the pad farther from Fish Creek would reduce the potential for contaminants to reach the creek, the likelihood of contaminants reaching the creek is already small and spills are not likely to have a measurable effect on arctic fish populations. No important fish habitat has been identified in the immediate area of the pad. Caribou and other subsistence resources may incur some disturbance during operations from infrastructure closer to riparian areas. However, elevating the pipeline to a minimum of 7 feet as measured at the VSMs; maintaining at least a 500-foot distance between the road and pipeline if feasible; restricting road use to industry, local residents, and government employees; and other design and operation features of the Preferred Alternative ensure that impacts to subsistence resources and uses are avoided or minimized.

STIPULATION 41

Stipulation 41 of the Northeast National Petroleum Reserve-Alaska IAP/EIS states:

> For those waterbodies not listed in stipulation 39, permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the highest high water mark of the active floodplain. Essential pipeline and road crossings will be permitted on a case-by-case basis.

The Northeast National Petroleum Reserve-Alaska IAP/EIS ROD contains the following definitions relevant to Stipulation 41:

> **Active Floodplain**: The lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands, including at a minimum that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain).
>
> **Body of Water or Waterbody**: A lake, river, stream, creek, or pond that holds water throughout the summer and supports a minimum of aquatic life.

The Preferred Alternative locates as much of the major infrastructure as possible on BLM-managed lands on relatively high and dry Moist Tussock Tundra and Moist Sedge-Shrub Meadow habitats and away from lakes and streams. However, the Plan Area, including that between CD-5 and CD-7, is characterized by many small water bodies. It may not be possible in all instances to avoid encroachment within 500 feet of every water body. Therefore, the Preferred Alternative would grant an exception to Stipulation 41 based on technical infeasibility.

The purpose of the 500-foot setback from water bodies is to protect fish, water quality, and aquatic habitat from impacts, including oil and fuel spills. On-the-ground inspections of the route of the road and pipeline determine where it is impossible to locate facilities outside of the 500-foot setback. It is anticipated that this inspection, along with existing stream and lake studies, would assist in agency determinations on facility design to minimize impacts to water bodies in any cases in which facilities cannot be placed 500 feet from water bodies. In addition, aspects of the applicant's proposed action, such as use of containment tanks and tank and pipeline inspections, and other Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations (e.g., 13 through 16) provide requirements that substantially reduce the potential for impacts to water bodies. As a consequence, the objectives of this stipulation would be met.

STIPULATION 48

Stipulation 48 of the Northeast National Petroleum Reserve-Alaska IAP/EIS states:

> Permanent roads (i.e. gravel, sand) connecting to a road system or docks outside the planning area are prohibited, and no exceptions may be granted. Permanent roads necessary to connect pads within independent, remote oil fields are allowed but they must be designed and constructed to create minimal environmental impacts. Roads connecting production sites between separate oil fields may be considered if road-connected operations are environmentally preferable to independent, consolidated operations that each include airstrip, housing, production, and support facilities. This exception will only be granted following consultations with appropriate Federal, State, and NSB regulatory and resources agencies, and the appropriate level of NEPA review.

As noted near the beginning of Section 2.4.6, BLM does not interpret the first sentence of this stipulation to be applicable to the applicant's proposed action. The roads from the different production pads connect only to APF-1 and not to a road system outside the Northeast National Petroleum Reserve-Alaska planning area. The Alpine Development in the Colville River Delta is roadless and does not connect to any outside road system. The oil accumulations at CD-5 are part of the Alpine Field, but those at CD-6 and CD-7 are geologically distinct from each other and from the Alpine Field. These accumulations may be considered separate "fields." Consequently, the third sentence of Stipulation 48 applies in the case of the applicant's proposed action.

The Preferred Alternative would allow roads connecting CD-6 with CD-7 and those two pads to the Alpine Field based on environmental factors. Locating an airstrip, housing, and support facilities with production facilities at both of these pads would require a large gravel footprint for the airstrips, generate additional air traffic, and introduce air, water, waste, and other impacts associated with human presence. A road from these pads to APF-1 allows operation of these pads to be accomplished from the base at APF-1. These pads will be unmanned, thus generating much less impacts than manned facilities. A gravel road also eliminates the need for regular ice road construction to these pads and reduces waste and chemical storage needs at separate pads. In addition, locating a road parallel to the pipeline facilitates pipeline leak detection and spill response.

The objective of Stipulation 48 is to protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources. Construction of roads is to be limited to those cases in which it is environmentally preferable to have roads rather than construct separate stand-alone facilities accessible only by air and ice road. Construction of the road linking CD-6 and CD-7 to APF-1 would meet the objective of the stipulation by eliminating impacts from duplicative airstrips, housing, and support facilities and from regular ice road construction, by providing better leak detection and spill response, and, because the road would be available for use by local residents, thus aiding access to traditional subsistence hunting and fishing areas.

2.5 COMPARISON OF FEATURES OF ALTERNATIVES

Table 2.5-1 summarizes the differences in features among the five action alternatives. Quantitative information, if available, is provided for each alternative.

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES

	Alternative A – Applicant's Proposed Action	Alternative B – Conformance to Stipulations	Alternative C – Alternative Access Roads		Alternative D – Roadless Development		Alternative F – Preferred Alternative
			Sub-Alternative C-1	Sub-Alternative C-2	Sub-Alternative D-1	Sub-Alternative D-2	
Pads							
Material	Armored gravel in lower Colville River Delta; gravel elsewhere.						
Location	Five Proposed Pads as CPAI proposed FFD No restrictions on locations.	Five Proposed Pads CD-6 moved outside 3-mile Fish Creek Buffer Zone. FFD Setbacks potentially eliminate or relocate production pads and HPFs .	Five Proposed Pads as CPAI proposed FFD No restrictions on locations.	Same as Sub-Alternative C-1	Five Proposed Pads as CPAI proposed FFD No restrictions on locations.	Five Proposed Pads as CPAI proposed FFD No restrictions on locations.	Five Proposed Pads as CPAI proposed
Gravel Quantity and Acreage (includes associated airstrips and aprons)	Five proposed pads 616,000 cy 68.6 acres FFD 3,815,000 cy 461.6 acres	Five proposed pads 1,155,000 cy 134.8 acres FFD 3,951,000 cy 467.40 acres	Five proposed pads 442,000 cy 47.2 acres FFD 2,806,000 cy 331.6 acres	Five proposed pads 458,000 cy 49.3 acres FFD Same as Sub-Alternative C-1	Five proposed pads 1,846,000 cy 221.5 acres FFD 8,859,000 cy 1,100.9 acres	Five proposed pads 673,000 cy 71.3 acres FFD 4,540,000 cy 544.7 acres	Five proposed pads 616,000 cy 68.6 acres
Millions of gallons of fresh water required, cumulative	Five proposed pads 410 FFD 940	Five proposed pads 420 FFD 1050	Five proposed pads 410 FFD 810		Five proposed pads 480 FFD 2,830	Five proposed pads 800 FFD Not calculated, extends 100 years.	Five proposed pads 410

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	Alternative B – Conformance to Stipulations	Alternative C – Alternative Access Roads		Alternative D – Roadless Development		Alternative F – Preferred Alternative
			Sub-Alternative C-1	Sub-Alternative C-2	Sub-Alternative D-1	Sub-Alternative D-2	
Process Facilities							
Expansions	Five Proposed Pads ACX-3 at CD-1 250 bbl CL tank at CD-1 FFD ACX-3 at CD-1 750 bbl CI tank at CD-1, HPF-1, and HPF-2						
Roads							
Road location	Five Proposed Pads as CPAI proposed FFD No restrictions on location; none to lower Colville River Delta pads.	Five Proposed Pads Moved outside 3-mile Fish Creek Buffer Zone. No road from CD-6 to CD-2. FFD Setbacks restrict areas in which roads can be placed; none allowed to cross from BLM-managed land to roads on state or private land; none to lower Colville River Delta pads.	Five Proposed Pads alternative routing FFD No restrictions on location; roads to lower Colville River Delta pads, alternative routing.	Five Proposed Pads Alternative routing; no road connection between CD-4 and CD-5; added road spur to proposed Colville River Road. FFD Same as Sub-Alternative C-1.	Five Proposed Pads None FFD None	Five Proposed Pads None FFD None	Five Proposed Pads Moved road segment near CD-4 out of Lake 9323; moved road segments from CD-5 to CD-7 outside 3-mile Fish Creek Buffer Zone.
Users of road	Industry, government agencies and local residents.	Industry and government agencies.	Unrestricted on BLM lands; industry, government agencies, and local residents elsewhere.	Unrestricted on BLM lands; industry, government agencies, and local residents elsewhere.	NA	NA	Industry, government agencies and local residents.

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	**Alternative B – Conformance to Stipulations**	**Alternative C – Alternative Access Roads**		**Alternative D – Roadless Development**		**Alternative F – Preferred Alternative**
			Sub-Alternative C-1	**Sub-Alternative C-2**	**Sub-Alternative D-1**	**Sub-Alternative D-2**	
Vehicle trips by industry, monthly vehicle round trips during construction	Five Proposed Pads Winter 2004/2005: 6,450 Summer 2005: 740 Winter 2005/2006: 6,250 Summer 2006: 2,270 Winter 2006/2007: 8,520 Summer 2007: 3,570 Winter 2007/2008: 4,570 Summer 2008: 9,020 Winter 2008/2009: 3,430 Summer 2009: 630 Winter 2009/2010: 2,080 Summer 2010: 7,680 Winter 2010/2011: 1,680 FFD Probably roughly within the same range as above for winter and summer; in proportion to the number of pads developed in a given year.	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.	Five Proposed Pads Winter 2004/2005: 6000 Summer 2005: 0 Winter 2005/2006: 5800 Summer 2006: 0 Winter 2006/2007: 3916 Summer 2007: 0 Winter 2007/2008: 4466 Summer 2008: 0 Winter 2008/2009: 3274 Summer 2009: 0 Winter 2009/2010: 1924 Summer 2010: 0 Winter 2010/2011: 1524 FFD Probably roughly within the same range as above; in proportion to the number of pads developed in a given year.	Five Proposed Pads Winter 2004/2005: 6000 Summer 2005: 0 Winter 2005/2006: 450 Summer 2006: 0 Winter 2006/2007: 482 Summer 2007: 0 Winter 2007/2008: 482 Summer 2008: 0 Winter 2008/2009: 498 Summer 2009: 0 Winter 2009/2010: 498 Summer 2010: 0 Winter 2010/2011: 1130 Five pad continues about 20 years. FFD Roughly within the same range as above every winter.	Same as Alternative A.

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	Alternative B – Conformance to Stipulations	Alternative C – Alternative Access Roads		Alternative D – Roadless Development		Alternative F – Preferred Alternative
			Sub-Alternative C-1	Sub-Alternative C-2	Sub-Alternative D-1	Sub-Alternative D-2	
Gravel quantity, lengths, and acreage for roads	Five proposed pads 1,371,000 cy[a] 26.0 miles 172.2 acres FFD 5,006,000 cy 121.8 miles 799.8 acres	Five proposed pads 483,000 cy 10.1 miles 68.7 acres FFD 3,695,000 cy 89.9 miles 588.4 acres	Five proposed pads 1,798,000 cy 42.1 miles 277.8 acres FFD 6,029,000 cy 147.2 miles 951.7 acres	Five proposed pads 1,778,000 cy 41.6 miles 274.4 acres FFD Same as Sub-Alternative C-1	Five proposed pads 0 cy 0 miles 0 acres FFD 0 cy 0 miles 0 acres	Five proposed pads 0 cy 0 miles 0 acres FFD 0 cy 0 miles 0 acres	Five proposed pads 1,365,000 cy 27.5 miles 182.4 acres
Bridge at Nigliq Channel	Road and pipeline near CD-2	Pipeline-only near CD-2	Road and pipeline near CD-4	Pipeline-only near CD-4	None	None	Road and pipeline near CD-2, longer than Alternative A bridge.
Boat ramps and docks	Five proposed pads and FFD Floating dock at CD-3, ramp at CD-4.	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.
Airstrips	Five proposed pads CD-3 FFD HP-7, HP-12, HP-13, HP-14, HP-22, HPF-1, and HPF-2	Five proposed pads CD-3, CD-5, and CD-6 FFD HP-7, HP-11, HP-12, HP-13, HP-14, HP-15, HP-17, and HPF-2	Five proposed pads None FFD HPF-1 and HPF-2	Five proposed pads None FFD HPF-1 and HPF-2	Five proposed pads At all pads. FFD A all pads, HP-4 shares with CD-4	Five proposed pads None, helipads at all pads. FFD None, helipads at all pads.	Five proposed pads CD-3

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	Alternative B – Conformance to Stipulations	Alternative C – Alternative Access Roads		Alternative D – Roadless Development		Alternative F – Preferred Alternative
			Sub-Alternative C-1	Sub-Alternative C-2	Sub-Alternative D-1	Sub-Alternative D-2	
Projected average aircraft flights per month for construction, drilling, and operations phases; fixed wing (F) includes 1-way Kuparuk into Alpine and round trip to well pads, helicopter (H) is round trip to production pads	Five Proposed Pads Winter 2004/2005: 160 F Summer 2005: 180 F Winter 2005/2006: 150 F Summer 2006: 462 F Winter 2006/2007: 176 F Summer 2007: 167 F Winter 2007/2008: 156 F Summer 2008: 246 F Winter 2008/2009: 164 F Summer 2009: 146 F Winter 2009/2010: 164 F Summer 2010: 255 F Winter 2010/2011: 167 F	Same as Alternative A.	Same as Alternative A.	Same as Alternative A.	Five Proposed Pads Winter 2004/2005: 70 F Summer 2005: 240 F Winter 2005/2006: 150 F Summer 2006: 510 F Winter 2006/2007: 184 F Summer 2007: 386 F Winter 2007/2008: 164 F Summer 2008: 925 F Winter 2008/2009: 172 F Summer 2009: 120 F Winter 2009/2010: 172 F Summer 2010: 838 F Winter 2010/2011: 183 F	Five Proposed Pads Winter 2004/2005: 70 F, 36 H Summer 2005: 180 F, 65 H Winter 2005/2006: 26 F, 38 H Summer 2006: 219 H Winter 2006/2007: 26 F, 118 H Summer 2007: 99 H Winter 2007/2008: 26 F, 70 H Summer 2008: 99 H Winter 2008/2009: 26 F, 70 H Summer 2009: 99 H Winter 2009/2010: 26 F, 70 H Summer 2010: 164 H Winter 2010/2011: 96 F,106 H Five-Pad Scenario continues approximately 20 years, traffic not estimated.	Same as Alternative A.

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	**Alternative B – Conformance to Stipulations**	**Alternative C – Alternative Access Roads**		**Alternative D – Roadless Development**		**Alternative F – Preferred Alternative**
			Sub-Alternative C-1	**Sub-Alternative C-2**	**Sub-Alternative D-1**	**Sub-Alternative D-2**	
Other access	Five Proposed Pads Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice road to CD-3; low ground pressure vehicles. FFD Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice roads to non-roaded pads in lower Colville River Delta during construction and drilling and every few years thereafter; low-pressure vehicles.	Five Proposed Pads Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice road to CD-3, CD-5, and CD-6 during drilling, every few years thereafter; annual ice roads and ice bridge across Nigliq; low pressure vehicles. FFD Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice roads to non-roaded pads in lower Colville River Delta and to pads or isolated roads in National Petroleum Reserve-Alaska not connected by road to Nuiqsut during drilling and every few years thereafter; low-pressure vehicles.	Same as Alternative A.	Same as Alternative A.	Five Proposed Pads Ice roads to all pads during road, pad, pipeline, and powerline construction. Ice road to all pads during construction and drilling and every few years thereafter; annual ice bridge across Nigliq; low pressure vehicles. FFD Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice roads to all pads during drilling and every few years thereafter; low-pressure vehicles.	Five Proposed Pads Ice roads to all pads during road, pad, pipeline, and powerline construction. Ice road to all pads during construction and drilling and every few years thereafter; annual ice bridge across Nigliq; low pressure vehicles. FFD Ice roads to all pads during road, pad, pipeline, and powerline construction. Annual ice roads to all pads during drilling and every few years thereafter; low-pressure vehicles.	Same as Alternative A.

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	Alternative B – Conformance to Stipulations	Alternative C – Alternative Access Roads		Alternative D – Roadless Development		Alternative F – Preferred Alternative
			Sub-Alternative C-1	Sub-Alternative C-2	Sub-Alternative D-1	Sub-Alternative D-2	
Miles of ice roads and millions of gallons of freshwater required	Five Proposed Pads 2005-2010: 303 miles FFD 2011-2015: 136 miles 2016-2018: 51 miles 2019-2022: 97 miles 2023-2026: 167 miles 2027-2030: 80 miles	Five Proposed Pads 2005-2010: 271 miles FFD 2011-2015: 141 miles 2016-2018: 54 miles 2019-2022: 145 miles 2023-2026: 180 miles 2027-2030: 101 miles	Five Proposed Pads 2005-2010: 326 miles FFD 2011-2015: 135 miles 2016-2018: 76 miles 2019-2022: 132 miles 2023-2026: 196 miles 2027-2030: 87 miles	Five Proposed Pads 2005-2010: 352 miles FFD Same as Sub-Alternative C-1	Five Proposed Pads 2005-2010: 386 miles FFD 2011-2015: 295 miles 2016-2018: 239 miles 2019-2022: 455 miles 2023-2026: 713 miles 2027-2030: 792 miles	Five Proposed Pads 2005-2010: 105 miles 2011-2015: 114 miles 2016-2018: 128 miles 2019-2022: 124 miles 2023-2026: 160 miles 2027-2030: 188 miles FFD Not estimated, would extend approximately. 100 years.	Five Proposed Pads 2005-2011: 315 miles
Pipelines							
Route	Five Proposed Pads As CPAI proposed. FFD No restrictions on location.	Five Proposed Pads Pipelines near CD-6 moved outside 3-mile Fish Creek Buffer Zone. FFD Setbacks restrict areas in which pipelines can be placed.	Five Proposed Pads Parallel roads. FFD No restrictions on location	Five Proposed Pads Parallel roads. FFD No restrictions on location.	Five Proposed Pads Nearly identical to CPAI Proposal. FFD No restrictions on location.	Five Proposed Pads Nearly identical to CPAI Proposal. FFD No restrictions on location.	Five Proposed Pads Pipeline segments between CD-5 and CD-7 moved outside the 3-mile Fish Creek Buffer Zone.
Elevation	5-foot minimum	5-foot minimum	7-foot minimum at VSMs	7-foot minimum at VSMs	7-foot minimum at VSMs	7-foot minimum at VSMs	7-foot minimum at VSMs
Length of pipeline corridor Number of VSMs	Five proposed pads 35.6 miles 3,418 VSMs FFD 150.1 miles 14,411 VSMs	Five proposed pads 36.5 miles 3,504 VSMs FFD 135.9 miles 13,044 VSMs	Five proposed pads 42.3 miles 4,059 VSMs FFD 148.7 miles 14,278 VSMs	Five proposed pads 42.3 miles 4,059 VSMs FFD 148.7 miles 14,278 VSMs	Five proposed pads 33.1 miles 3,121 VSMs FFD 150.1 miles 14,405 VSMs	Five proposed pads 33.1 miles 3,121 VSMs FFD 150.1 miles 14,405 VSMs	Five proposed pads 37.1 miles 3,561 VSMs

TABLE 2.5-1 COMPARISON OF COMPONENTS OF THE ALTERNATIVES (CONT'D)

	Alternative A – Applicant's Proposed Action	**Alternative B – Conformance to Stipulations**	**Alternative C – Alternative Access Roads**		**Alternative D – Roadless Development**		**Alternative F – Preferred Alternative**
			Sub-Alternative C-1	**Sub-Alternative C-2**	**Sub-Alternative D-1**	**Sub-Alternative D-2**	
Pipeline at Nigliq Channel	On bridge near CD-2	On pipeline-only bridge near CD-2	On bridge near CD-4	On pipeline-only bridge near CD-4	Under channel near CD-2	Under channel near CD-2	On bridge near CD-2
Powerlines	In cable trays mounted on VSMs, except 60-foot high poles at 250-foot spacing from CD-6 to CD-7	Buried in/under road or at toe of slope of road everywhere there is a road. Hung off of road bridges at stream crossings. Where no roads, buried in tundra adjacent to pipeline. Hung off pipeline bridges at stream crossings, trenched across minor drainages.	Strung along 60-foot high power poles, 250-foot spacing.	Strung along 60-foot high power poles, 250-foot spacing.	In cable trays mounted on VSMs.	In cable trays mounted on VSMs.	In cable trays mounted on VSMs.

Note:

Under all alternatives, environmental impact analysis considers whether burying specific portions of the pipeline in the tundra or road or raising the pipeline height above the prescribed 5-foot or 7-foot height would mitigate adverse impacts to each resource or use. Such analysis will be based, not on the assumption that the pipeline will be the prescribed minimum height above the tundra, but on projections of the height of the pipeline in the specific portion of the pipeline route. Depending on topography, the height can be substantially greater than the minimum.

[a] Gravel quantities for Alternative A obtained from CPAI's ASDP Permit Application. Gravel quantities for all other alternatives were calculated based on GIS measurements.

2.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

The following alternatives and suggested elements of alternatives were considered but not carried forward for further detailed analysis as an alternative. However**,** these alternatives or suggested elements may be applied as site-specific mitigation measures.

2.6.1 Buried Pipelines

The BLM considered requiring burial of all pipelines, either in gravel roadways or in the tundra. Buried pipeline may ensure easier travel by both humans and wildlife and would be more aesthetically pleasing.

Pipeline burial in roads or the tundra has rarely been used on the North Slope, except in thaw-stable soils such as the case of the TAPS along the Sagavanirktok River. Some three-phase pipelines were initially buried in the roadbed at Milne Point. Problems with these pipelines have resulted in many of these lines being abandoned, and more recent pipeline construction at Milne Point has been above ground because of the problems with belowground pipelines.

Burying pipelines has definite adverse impacts. Pipeline burial can result in thermokarsting, corrosion, erosion, and leak risk (from both external corrosion and pipeline movement). The Milne Point pipeline buried in the roadbed has had problems with corrosion and pipeline movement from expansion and contraction and from frost. Buried pipeline in permafrost areas is prone to heaving, thaw settlement, and thermokarsting, as has been the case for the TAPS fuel gas line, two Badami pipeline river crossings, and at a more recent test trench project for a possible gas sales line. Bank erosion at the site of the Colville River crossing of the sales pipeline for the Alpine Development Project has occurred, and may be attributable to the pipeline. Leaks, especially small leaks, in buried pipeline also are harder to detect than in aboveground pipelines, and consequently more product can reach the environment before a leak is stopped. This difficulty in detecting leaks can be even more problematic with three-phase pipelines for which leak detection is less sensitive than for crude-oil pipelines. Buried pipeline installation also destroys or disturbs soils and vegetation and disrupts natural drainages. Finally, burying the pipeline would increase the cost of the applicant’s proposed action.

Because of the environmental risks associated with buried pipelines, burying pipelines in a road or the tundra does not achieve the purpose of the applicant’s proposed action while minimizing environmental harm and is not a reasonable alternative, except where it can be shown that it provides specific environmental benefits that offset its considerable disadvantages. Without a clearly identified site-specific environmental benefit for burying a particular pipeline or a portion of a pipeline, burial of all pipelines will not be considered further as an alternative. However, pipeline burial will be considered as appropriate mitigation for particular site-specific impacts rather than as an alternative for total pipeline placement.

2.6.2 Pipeline Elevated Greater Than Seven Feet

The BLM considered elevating the pipeline to a minimum higher than the 5-foot and 7-foot minimums considered in the alternatives selected for detailed analysis. It is possible, though it has not been shown, that pipelines elevated 10 feet or more may ensure even easier travel both by humans and wildlife. However, current information is that 7-foot pipeline elevations are adequate for passage.

To date, no North Slope pipeline project has required more than a 7-foot minimum height elevation. Higher pipeline elevation would make pipelines visible from greater distances and increase work safety concerns and construction, maintenance, and repair costs.

Therefore, as is the case with burying pipeline, raising the minimum level above that considered in the alternatives presented in this EIS does not achieve the purposes of the applicant’s proposed action, and is not a reasonable alternative, except where it can be shown that it provides specific environmental benefits that offset its significant disadvantages. Without a clearly identified site-specific environmental benefit for higher pipeline elevations at a particular location, this alternative was eliminated from consideration. Because higher minimum elevated pipeline is untested, entails its own risks of adverse impacts, and is more costly, this EIS has considered raising the minimum height above 7 feet only for mitigation of site-specific impacts, rather than as an alternative for total pipeline placement throughout the pipeline routes.

2.6.3 Pile-Supported Production Pads

Pile-supported production pads offer the possibility of reducing gravel needs and associated impacts from gravel pits and pads. However, pile-supported production pads currently are used only experimentally for relatively shallow exploratory wells. In the winter of 2002–2003, Anadarko Petroleum Corporation first deployed its pioneering pile-supported exploration pad on the North Slope, drilling to 1,400 feet (Maurer Technology 2003). Such a rig is far too small to reach the drilling target depths in the Plan Area. Although in the future they might be developed for production pad use, pile-supported production pads currently are not technologically capable of providing the structures necessary for this proposed action**,** and therefore are not a reasonable alternative for the applicant’s proposed action.

2.6.4 Use of Docks to Develop Facilities

Docks are not a practical alternative means of developing the facilities proposed by CPAI. Use of docks within the Colville River Delta is infeasible because of the shallow depth, changing distributary channels, and maintenance dredging and associated dredge spoil disposal that would be needed. Docks located elsewhere along the Beaufort Sea coastline would be too far away from the proposed development. Therefore, the use of docks is not a reasonable alternative for the CPAI proposal**.** Winter hauling on ice roads or over the frozen tundra, lakes, and streams is much more practical for both environmental and logistical reasons. This approach is the most likely means to develop future proposed facilities in the Plan Area.

2.6.5 Conduct Long-Term Studies on North Slope Habitat, Wildlife, and Social Impacts

Some local residents would like the government to conduct long-term studies of local and regional environmental, health, and social issues. The BLM and the USGS are in the process of establishing a body to undertake such studies, partially in response to the findings and recommendations in the report of the National Research Council (NRC) of the National Academy of Science. This BLM- and USGS-led body is the appropriate vehicle for undertaking long-term studies such as those the residents have requested. Such studies, however, are not within the scope of the purpose and need of the applicant’s proposed action and are not a reasonable alternative to accomplish those purposes.

2.6.6 Required Three-Mile Setback from all Rivers, Streams, and Lakes

Leaders of the village of Nuiqsut suggested a 3-mile setback from all rivers, streams, and lakes. The planning area contains so many water bodies within its entire area that a 3-mile restriction on surface occupancy throughout the area would effectively prohibit any development in the entire planning area. Thus, an alternative adopting this suggestion would be inconsistent with the purpose and need of the applicant’s proposed action, and is not a reasonable alternative**.** However, setbacks of varying widths are required around all water bodies on BLM-managed public lands and are under consideration as mitigating measures on other lands in the Plan Area**.**

2.6.7 Approval of Fewer Satellite Development Pads or Pads at Substantially Different Locations

Development of fewer pads or pads at substantially different locations would not meet the purpose of the applicant’s proposed action and therefore is not a reasonable alternative to the proposed action. Fewer pads would not be able to produce the oil accumulations that the applicant proposes to develop. The economics and technological limitations of North Slope oil development are such that CPAI has designed its proposal with the minimum facilities necessary to produce the discovered oil. Placing production pads at points distant from the locations proposed by CPAI would make production of the oil economically and technologically infeasible. Directional drilling has distinct limitations, and it is necessary to locate production pads so as to enable all portions of each reservoir to be accessed sufficiently to produce all the accumulated oil from a minimum of pads, or oil will be left. Therefore, more distant locations of production pads was also eliminated as an alternative to be considered in detail.

2.6.8 Develop Western Part of the Satellite Development from a Nuiqsut Operations Center

The BLM considered an alternative that would have located a new staging area and operations center at Nuiqsut. Conceptually a Nuiqsut Operations Center (NOC) would serve as a storage area and transportation hub at the village of Nuiqsut to support construction, drilling, and operation of CPAI's proposed drill sites CD-5, CD-6, and CD-7. Use of an NOC would reduce the need for a vehicle bridge over the Colville River and could provide some additional economic benefit to the village of Nuiqsut.

However, the BLM concluded that an NOC is not a practical alternative means of developing the oil accumulations CPAI proposes to develop west of the Nigliq Channel. Use of a NOC would necessitate the purchase, operation, and maintenance of numerous duplicate pieces of equipment and infrastructure that are already in place at the Alpine Development Project. Essentially the NOC would be a duplicate of the Alpine Development Project without the hydrocarbon processing facilities and the camp (although the camp size may be able to be reduced). The size and extent of CPAI's proposed satellite development west of the Nigliq Channel does not support the level of activity that would justify the capital investment required for aNOC. The projected level of development in the National Petroleum Reserve-Alaska would not support the additional expense involved with an NOC. Therefore, an alternative dependent on a NOC would not be economically viable and was eliminated from detailed analysis as an alternative.

2.6.9 Development with Access Other than Road or Air

The BLM considered requiring oil development in the Plan Area to proceed with access other than by gravel road or air. Gravel road and aircraft access both affect the environment through gravel extraction, establishment of gravel road or airstrip/helipad footprints on the tundra, and disturbance of wildlife through noise and movement. Boat access, such as CPAI has proposed to CD-3 and CD-4, offers a partial alternative means of access in summer, at least for those pads that are reasonably accessible by boat. Use of low-pressure vehicles year-round on tundra offers another means to access pads, as do ice roads.

An alternative that relies on such means of access for all but emergency purposes to develop oil and gas in the Plan Area, however, is not a reasonable alternative because it fails to provide adequate continuous access to achieve the purpose and need described in Section 1. Neither the federal nor state governments permit other than emergency tundra travel during all or portions of the summer to prevent undue damage to the environment when the ground is soft. Regular routine maintenance and inspection trips to production pads during summer by low-pressure vehicles would result in sustained and substantial damage to vegetation, soils, and water resources, including important wetland habitat. Vehicle crossings of rivers and streams would result in unacceptable damage to riparian resources and fish habitats and is prohibited in anadromous water bodies with few exceptions. Crossing channels of the Colville River or other streams, including the Ublutuoch River, with low-pressure vehicles is not feasible during some periods because of break-up, freeze-up, or high flow conditions. Although boat travel offers a means to access CD-3 and CD-4 during the summer, boat access is not available to CPAI's other proposed sites. Moreover, boat access is not possible or safe during break-up and freeze-up. Therefore, alternatives other than air or road access are not considered feasible and were not considered in detail in this EIS.

2.7 COMPARISON OF IMPACTS OF ALTERNATIVES FOR CPAI PROPOSED DEVELOPMENT

Table 2.7-1 provides a comparison of impacts of the applicant’s proposed action (Alternative A) and four action alternatives (Alternatives B, C, D, and F), including the cumulative impacts. Alternative E is the No Action Alternative. Under Alternative E, development in the Plan Area would not be authorized. No oil in the Plan Area, except that extracted through the existing APF, would be produced, and no new roads, airstrips, pipelines, or other oil facilities would be constructed beyond what is authorized in connection with CPAI’s current development at CD-1 and CD-2. None of the physiographic, biological, or social system impacts described for the other alternatives in Section 4 and summarized below would occur. The physiography would not be altered. Oil and gas and sand and gravel would not be exploited for the applicant’s proposed action. Soils, permafrost, water, water quality, air, climate, paleontological and cultural resources, and wildlife and their habitats would not be disturbed or destroyed. There would be no impacts on subsistence, socio-cultural systems, the economy, recreation, or visual resources.

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES

<table>
<tr><th colspan="5">Physical: Terrestrial – Physiography</th></tr>
<tr><th>Alternative A</th><th>Alternative B</th><th>Alternative C</th><th>Alternative D</th><th>Alternative F</th></tr>
<tr><td>Impacts to physiography would result in changes to landforms by construction of roads, pads, airstrips, and mine sites. If not properly designed and constructed, gravel fill can adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding. The total land area affected by construction of gravel facilities and mine sites would be 306 acres.</td><td>Same types of impacts as Alternative A. Lesser magnitude of land-intrusive actions than Alternative A because of fewer roads, shorter road lengths, and fewer acres involved with gravel mining. The total land area affected by construction of gravel facilities and mine sites would be 241 acres.</td><td>Same types of impacts as Alternative A. Greater magnitude of land-intrusive actions than Alternative A because of additional roads, longer road lengths, and more acres involved with gravel mining. The total land area affected by construction of gravel facilities and mine sites = 409 acres for Sub-Alternative C-1 and = 410 acres for Sub-Alternative C-2.</td><td>Same types of impacts as Alternative A. Lesser magnitude of land-intrusive actions than Alternative A because of roadless design, Total area of gravel construction and mining actions = 272 acres for Sub-Alternative D-1 and 93 acres for Sub-Alternative D-2.</td><td>Same types of impacts as Alternative A. Similar magnitude of gravel construction and mining actions as Alternative A. Total area of land affected by gravel construction and mining actions = 316 acres.</td></tr>
<tr><td>SPILLS: Spills would not affect the physiography except at a local scale on the order of acres. Spills may cause loss of vegetation, resulting in thermokarsting and possible pond formation. Spill cleanup may remove vegetation and surface soils, which also may cause thermokarsting.</td><td>SPILLS: Same as Alternative A, except there may be fewer spills from vehicles to gravel roads and adjacent habitats because there are fewer miles of roads.</td><td>SPILLS: Same as Alternative B, except there are even fewer miles of gravel roads.</td><td>SPILLS: Same as Alternative A, except there would be no gravel spills from road construction. There may still be gravel spills on ice roads destined for pads and airstrips.</td><td>SPILLS: Same as Alternative A.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Impacts to the physiography are associated with the development and construction of gravel pads, roads, airstrips, pipelines, and pump stations. The largest cumulative impacts on physiography are anticipated from gravel mining and it associated activities. The proportion contributed by the ASDP is relatively small compared to the effects of past, present, and reasonably foreseeable actions. While physiographic impacts, especially those resulting from gravel mining, are additive, the total incremental amount of disturbed area is small compared to the total resources within the North Slope region and is not considered to be cumulatively significant.</td></tr>
<tr><th colspan="5">Physical: Terrestrial – Geology</th></tr>
<tr><th colspan="5">All Action Alternatives</th></tr>
<tr><td colspan="5">Under all development scenarios, the irreversible and irretrievable commitment of petroleum hydrocarbon resources constitutes a major impact; however, petroleum hydrocarbon production is the purpose of the project. Impacts to bedrock under all alternatives would be negligible.</td></tr>
<tr><td colspan="5">SPILLS: Spills would not affect geology.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Cumulative geological impacts are mainly additive, and, given the objective of oil development, are unavoidable. The proposed action would likely remove a significant percent of total economically recoverable petroleum resources available within the area of known reserves, just as past, present, and reasonably foreseeable development has and will continue to remove oil from other known and perhaps as yet unknown fields.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Physical: Terrestrial – Soils and Permafrost				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Placement of fill on the tundra represents the greatest impacts on Plan Area soils and permafrost. Impacts that increase heat flux to ice-rich permafrost can initiate thermokarst. Impacts to Plan Area soil and permafrost resources would be unavoidable and semipermanent. Alternative A would place gravel or ice over 1,757 acres of soil, disturb 2.0 million cubic yards (Mcy) of soil through gravel excavation, and thermally impact 1,152 acres of tundra. The surface area of soil affected both directly and indirectly under Alternative A represents 0.2% of the total Plan Area.	Direct and indirect impact types similar to Alternative A. Lesser magnitude of road construction impacts. Surface area of soil disturbed = 1,556 acres, Volume of soil disturbed = 1.6 Mcy, Percent of Plan Area disturbed = 0.2%.	Direct and indirect impact types similar to Alternative A. Greater magnitude of gravel excavation and road construction impacts. Surface area of soil disturbed =1,993 acres (C-1) and 1,979 acres (C-2), Volume of soil disturbed = 2.2 Mcy (C-1) and 2.2 Mcy (C-2), Percent of Plan Area disturbed = 0.2% (C-1) and 0.2% (C-2).	Direct and indirect impact types similar to Alternative A. Minimal gravel road construction impacts, greater ice road construction impacts. Surface area of soil disturbed = 2,145 acres (D-1) and 602 acres (D-2), Volume of soil disturbed = 1.8 Mcy (D-1) and 0.7 Mcy (D-2), Percent of Plan Area disturbed = 0.2% (D-1) and <0.1% (D-2).	Direct and indirect impact types similar to Alternative A. Similar magnitude of road construction impacts. Surface area of soil disturbed = 1,845 acres, Volume of soil disturbed = 2.0 Mcy, Percent of Plan Area disturbed = 0.2%
SPILLS: Spills of oil and/or salt water may affect soils directly and make them unsuitable for survival of tundra vegetation, with the impact persisting longer for salt water than for oil, which weathers. The loss of vegetation as a result of spilled material and/or from cleanup actions may expose soil and underlying permafrost to thermokarsting as well as wind erosion processes. A VLVS may affect larger areas (which may also be remote from roads) than will most very small to medium and some large spills. Saltwater spills may have a smaller impact in wetland and wet tundra habitats occupied by halophytic (salt-loving) plants than in habitats farther from the coast and the Colville River estuary.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that a VLVS may take longer to contain and clean up if it occurs when there is no ice road access, thus increasing the time that the spilled material may affect the vegetation and expose soil and permafrost.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Impacts to soils and permafrost occur from activities associated with construction of gravel pads, roads, airstrips, pipelines, and pump stations and the excavation of material sites. Incremental impacts of the proposed project would be small (on the order of 2 percent) when compared to past, present, and future development. While soils and permafrost impacts are additive, the total and incremental amount of disturbed area is small compared to the total resource within the North Slope region and is not considered to be cumulatively significant.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Physical: Terrestrial – Sand and Gravel				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Sand and gravel resources used for construction of roads, pads, or airstrips would be available for reuse only upon abandonment. For Alternative A, 2.0 Mcy of gravel fill are required.	Requires 1.6 Mcy of sand and gravel for use as fill.	Requires 2.2 Mcy of sand and gravel for Sub-Alternative C-1 and 2.2 Mcy of sand and gravel for Sub-Alternative C-2 for use as fill.	Requires 1.8 Mcy of sand and gravel for Sub-Alternative D-1 and 0.7 Mcy of sand and gravel for Sub-Alternative D-2 for use as fill.	Requires 2.0 Mcy of sand and gravel for use as fill for construction of roads, pads, or airstrips.
SPILLS: Most spills are very small to medium and occur on gravel roads and pads. The spills may contaminate the gravel, depending upon its re-use upon abandonment of the facilities.	**SPILLS:** Same as Alternative A, except there are somewhat fewer miles of road and less gravel to be affected.	**SPILLS:** Same as Alternative A, except there are even fewer miles of gravel roads than in Alternatives A or B.	**SPILLS:** Same as B except there are no gravel roads to be affected. The pads may still be affected.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Use of sand and gravel resources reduces the availability of the remaining resources for future use. The contribution the ASDP to additive cumulative gravel and sand use (as measured by surface area) is approximately 5%, significantly less than the approximately 50% increase that would occur for the total of and reasonably foreseeable future development. The ASDP would result in increased cumulative impacts, although the incremental cumulative impacts that result are a small portion the cumulative impacts that result from all other reasonably foreseeable future projects. Once used, sand and gravel resources for construction of roads, pads, or airstrips may only be available for reuse upon abandonment.				

Physical: Terrestrial – Paleontological Resources				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Surface activities such as construction of pad, road, and airfield embankments are not likely to affect paleontological resources. Impacts could result from those activities involving subsurface disturbance such as sand and gravel mining. Gravel mining would cover 65 acres.	Less chance for subsurface disturbance because of 28 fewer acres of gravel mining than Alternative A.	More chance for subsurface disturbance because of 21 (C-1 and C-2) more acres of gravel mining than Alternative A.	Less chance for subsurface disturbance because of 14 (D-1) and 43 (D-2) fewer acres of gravel mining than Alternative A.	Same as Alternative A.
SPILLS: No impact from spills expected unless there are unknown paleontological resources discovered in the course of a cleanup response to a spill.				
CUMULATIVE IMPACTS: While the nature of paleontological deposits (specifically, their unpredictable location and context on surface, near-surface, or deeply buried) make impacts difficult to assess, the continued use of current procedures for survey and inventory before exploration and development are expected to minimize the potential for impacts to occur. Effects across the North Slope of Alaska are expected to be additive and minor. Because the probability that a large oil spill would occur is extremely low (see discussion in Section 4.3), the potential for any cumulative oil spill impacts on paleontological resources is considered to be minimal.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Physical: Aquatic – Water Resources				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Shallow, thawed water-bearing zones may be enlarged or eliminated and lakes may be created during construction, operation, and abandonment of gravel extraction areas. Fresh water withdrawn from lakes for the construction of ice roads and pads during the winter seasons, for production drilling and processing operations, and for potable water at temporary construction or drilling camp facilities, would result in negligible impacts to lake water levels because natural annual recharge processes are sufficient to fully recharge lakes. Creeks could be affected when construction and operation activities associated with roads and pipelines block, divert, impede, or constrict flows, resulting in impoundment of water. Constricting flows could result in increased stream velocities and a higher potential for ice jams, ice impacts, scour and streambank erosion. Impeded flows could result in bank overflows and floodplain inundation. These potential impacts are minimized by design features that protect the structural integrity of road- and pipeline-crossing structures. Total fresh water requirement would be 713 million gallons.	Same as Alternative A, except that CD-6 and gravel roads associated with CD-2, CD-5, and CD-6 would be eliminated, minimizing (when compared to Alternative A) the potential impacts on water resources along these segments. Total fresh water requirement = 691 million gallons.	Same as Alternative A, except the road to CD-3 could have adverse effects on the peak water surface elevations. In addition, the road could be affected by storm surges related to elevated sea levels offshore. Elimination of the road-bridge over the Nigliq Channel would reduce impacts in Sub-Alternative C-2. Total fresh water requirement for Sub-Alternatives C-1 and C-2 = 736 million gallons.	Same as Alternative A, except elimination of gravel roads would reduce the overall impacts on water resources (e.g., fewer impacts to streams and rivers because of reduced road and pipeline crossings; fewer impacts on shallow subsurface waters from reduced gravel supply requirements); ice road construction would increase, creating an increased demand for water. The ability to spread out water extraction to other permitted lakes, and natural annual recharge volumes, would result in negligible impacts on lakes. Total fresh water requirement for Sub-Alternative D-1 = 866 million gallons, Sub-Alternative D-2 = 905 million gallons.	Same as Alternative A. Rerouting of the CD-4 road would minimize impacts on a nearby lake. Provisions for culvert criteria would reduce impoundment of waters compared to Alternative A. Longer bridge spans could reduce flow restriction and related erosion and shoaling. Total fresh water requirement = 661 million gallons.

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Physical: Aquatic – Water Resources (cont'd)</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td>SPILLS: Oil spills may affect water bodies near pipelines or roads and pads. A VLVS is more likely to affect these water bodies than will very small to medium spills, most of which are confined to the roads and pads. Oil spill impacts may persist for several years until oil remaining after cleanup weathers. A saltwater spill may affect the water body for a few months to few years, depending upon the input of fresh water to dilute and flush out the salt water.</td><td>SPILLS: Same as Alternative A, except that there would be fewer spills from gravel roads because of the reduction in the miles of roads between CD-1 to CD-3, and CD-1 to CD-6. Thus, the likelihood and impacts from vehicle spills will be less than in Alternative A. Also, the road, pipeline, and pad would be out of the Fish Creek Buffer Zone, thus reducing potential impacts on Fish Creek.</td><td>SPILLS: Same as Alternative A, except that then potential for spills to reach Fish Creek would be reduced by moving most of the pipelines and the roads out of the Fish Creek Buffer Zone.</td><td>SPILLS: Same as Alternative A, except that there would be no spills from gravel roads, and spills from ice roads are likely to be cleaned up before ice melts in spring. Thus, the likelihood and impacts from vehicle spills will be less than in Alternatives A, B, or C.</td><td>SPILLS: Same as Alternative A, except that then potential for spills to reach Fish Creek would be reduced by moving most of the pipelines and the roads out of the Fish Creek Buffer Zone.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Development of oilfield facilities, associated transportation systems, and at settlements has and will continue to affect water resources. These impacts are most likely to be related to road development, currently approximately 570 miles (including the Dalton Highway) on the North Slope outside of villages. Development of the ASDP contributes up to 26 miles of additional road to the cumulative total of roads. No cumulative impact on North Slope water supplies from withdrawal of water for construction and operation of any of the alternatives is expected because the annual yield (runoff and refill of lakes) is many times greater than the amount withdrawn. Localized and temporary impacts may occur at those lakes used for water supply.</td></tr>
<tr><th colspan="5">Physical: Aquatic – Surface Water Quality</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td>Potential surface water quality impacts that could occur during construction and operation include accidental release of fuels and other substances, including oil spills; reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply; and increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations.</td><td>Would have fewer sources of potential impacts on surface water quality than Alternative A because of the movement of several production facilities outside sensitive resource areas and reduction in total miles of roads to be constructed. Facilities would be located farther from water bodies compared to Alternative A, reducing the chance of accidental releases migrating into a nearby water body. Reduced potential for dust fallout and upslope impoundments compared to Alternative A would result in fewer incidences of turbidity impacts.</td><td>Would have more sources of potential impacts on surface water quality than Alternative A because of the increased roads requiring more gravel placement. Increased miles of ice roads compared to Alternative A would raise the chance that ice roads would be routed across lakes, potentially affecting dissolved oxygen concentrations. Increased area potentially affected by thermokarst erosion, dust fallout, and upslope impoundments compared to Alternative A, leading to increased impacts on water quality from increased turbidity.</td><td>Would have fewer sources of potential impacts on surface water quality than Alternative A because of the decreased gravel placement.
Increased miles of ice roads compared to Alternative A, resulting in increased water withdrawal and increased potential that ice roads would be routed across lakes, potentially affecting dissolved oxygen concentrations. Decreased area potentially affected by thermokarst erosion compared to Alternative A, reducing the potential for turbidity impacts caused by erosion and sedimentation. Minimal potential for dust fallout and upslope impoundments compared to Alternative A, resulting in less potential for turbidity impacts.</td><td>Would have more sources of potential impacts on surface water quality than Alternative A because of the increased roads. Increased miles of ice roads compared to Alternative A would raise the chance that ice roads would be routed across lakes, potentially affecting dissolved oxygen concentrations. Increased area potentially affected by thermokarst erosion, dust fallout, and upslope impoundments compared to Alternative A, leading to increased turbidity impacts.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Physical: Aquatic – Surface Water Quality (cont'd)</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td>SPILLS: Oil spills may affect water bodies near pipelines or roads and pads. A VLVS is more likely to impact these water bodies than will very small to medium spills, most of which are confined to the roads and pads. Spills that reach surface water bodies, depending upon the type of material spilled, may result in reduced dissolved oxygen concentrations, increased salt concentrations, and increased toxicity to aquatic organisms. The concentrations may exceed state water quality standards for a few days to a few years, depending upon the size and dynamics of the receiving water body, rate of dilution, and/or weathering of the spilled material.</td><td>SPILLS: Same as Alternative A, except that there would be fewer spills from gravel roads because of the reduction in the miles of roads between CD-1 to CD-3, and CD-1 to CD-6. Thus, the likelihood and impacts from vehicle spills will be less than in Alternative A. Also, the road, pipeline, and pad would be out of the Fish Creek Buffer Zone, thus reducing potential impacts on Fish Creek.</td><td>SPILLS: Same as Alternative A, except that the potential for spills to reach Fish Creek would be reduced by moving most of the pipelines and the roads out of the Fish Creek Buffer Zone. Also, there are even fewer miles of gravel roads than in Alternatives A or B.</td><td>SPILLS: Same as Alternative A, except that there would be no spills from gravel roads, and spills from ice roads are likely to be cleaned up before ice melts in spring. Thus, the likelihood and impacts from vehicle spills will be less than in Alternatives A or B.</td><td>SPILLS: Same as Alternative A, except that the potential for spills to reach Fish Creek would be reduced by moving most of the pipelines and the roads out of the Fish Creek Buffer Zone.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Impacts from development of the ASDP and other reasonably foreseeable actions to surface water quality across the North Slope would be additive, and are also expected to be localized, limited in extent and persistence, and have minimal impact on the environment. Such impacts are not expected to be cumulative.</td></tr>
<tr><th colspan="5">Physical: Aquatic – Estuarine Waters and Water Quality</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td colspan="5">Since the pad, road, and pipeline locations are not near the coast, no expected impacts on the physical conditions or processes within the estuarine and nearshore environment are expected.</td></tr>
<tr><td>SPILLS: Large to VLVS to major creeks (e.g., Fish and Judy creeks and Ublutuoch River)) and rivers (e.g., Nigliq Channel, Colville River Delta) may affect estuarine water quality by reducing dissolved oxygen concentrations, increasing salt concentrations, and increasing toxicity levels. The impacts are most likely to come from spills from pipelines crossing the rivers and creeks and may persist from a few days to several years, depending on the material spilled and the dynamics of the water body and nearshore sediment accretion, erosion, and transport processes.</td><td>SPILLS: Same as Alternative A.</td><td>SPILLS: Same as Alternative A, except that pipeline crossings of Ublutuoch River and Nigliq Channel are farther upstream, which may reduce the amount of spilled material that reaches the estuarine environment.</td><td>SPILLS: Same as Alternative A.</td><td>SPILLS: Same as Alternative A.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: The ASDP is not expected to contribute to cumulative impacts on marine and estuarine water quality. Spills from other oil and gas developments on marine or estuarine waters or along streams draining into such water bodies could affect those waters. The extent of such contamination would be related to the size of the oil spill. Because spill frequency and volume are expected to be low, cumulative impact from oil spills is not considered to be an additive cumulative impact.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Physical: Atmospheric Environment – Climate and Meteorology</th></tr>
<tr><th colspan="5">ALL ACTION ALTERNATIVES</th></tr>
<tr><td colspan="5">Greenhouse gas emissions would occur during construction and drilling activities from operation of fossil fuel combustion equipment. GHG emissions would also occur over a longer period from operations. The impact of GHG emissions upon the air quality of the region would be minimal.</td></tr>
<tr><td colspan="5">SPILLS: No detectable impacts from spills.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: While it is difficult to estimate GHG emissions from future oil and gas production activities in northern Alaska precisely, GHG emissions would conservatively continue to be proportional to the oil production rate at approximately the same ratio as now. Based on that assumption, not taking into account combustion and emission control technology improvements, the regional GHG emission associated with future cumulative production, including the ASDP, would be approximately the same as the 1996 North Slope emission levels. This is approximately 27 percent higher than current levels (since the 1999 North Slope production rate was approximately 1.1 MMbbl of oil per day).</td></tr>
<tr><th colspan="5">Physical: Atmospheric Environment – Air Quality</th></tr>
<tr><th colspan="5">ALL ACTION ALTERNATIVES</th></tr>
<tr><td colspan="5">Construction and Operations would result in air emissions in the region. The emissions would not have a lasting effect on air quality.</td></tr>
<tr><td colspan="5">SPILLS: Localized impact may occur from oil spills and from some volatile hazardous materials, primarily from VOCs released to the atmosphere. The potential impacts may be greater if the hydrocarbon is sprayed under high pressure as a mist into the air. There would be no impacts from saltwater spills.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: The cumulative effects of all projects affecting the North Slope of Alaska in the past and occurring now have caused generally little deterioration in air quality, which achieves national standards. Production levels for the foreseeable future are not anticipated to be higher than the 1996 level. Thus, while the ASDP and reasonably foreseeable North Slope projects are additive, they are not expected to have synergistic cumulative impacts on air quality.</td></tr>
<tr><th colspan="5">Physical: Atmospheric Environment – Noise</th></tr>
<tr><th colspan="5">ALL ACTION ALTERNATIVES</th></tr>
<tr><td colspan="5">Generally, the equipment in the Plan Area would operate at a decibel level of about 70 dBA for less than 1,000 feet. During drilling, the potential noise impacts would be limited to the vicinity of the power generation engines and drilling rig engines, which would have equipment decibel ratings of about 85 dBA and 110 dBA, respectively. During peak periods of construction and drilling, noise levels would be considerably higher than during operations, but would be short-term and would not occur for all proposed satellite pads at the same time. Noise impacts to residents of Nuiqsut would be negligible.</td></tr>
<tr><td>SPILLS: Releases of oil or salt water under pressure may result in a local increase in noise of the escaping liquid and gas. Much or the response equipment is motorized, and the local noise levels will increase from both the equipment and the people involved, compared to noise levels from normal operations. The increased noise levels will be localized and would cease as the spill response ends.</td><td>SPILLS: Same as Alternative A.</td><td>SPILLS: Same as Alternative A.</td><td>SPILLS: The noise levels may be greater at the cleanup site(s) because there may be more aircraft support instead of trucks and other ground vehicles used to transport people, materials, and machinery to the site(s). Also, the aircraft, especially helicopters will be transporting people, materials, etc. from central locations to the site and thus flying over the tundra.</td><td>SPILLS: Same as Alternative A.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: The ASDP would result in negligible incremental increases in localized ambient noise from construction and operations equipment and aircraft. From the cumulative perspective, noise effects from infrastructure and activities related to past, present, and reasonably foreseeable actions are localized and short term, and the sources of noise are not geographically concentrated.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Terrestrial Vegetation and Wetlands				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
306 acres covered by fill and mining, 1,152 acres altered by indirect impacts. Ice road construction would disturb 1,816 acres and may damage underlying vegetation from direct damage or as a result of long-term compaction by use of roads for several years (e.g., by crushing tussocks). In the Colville River Delta, the highest surface area impacts are to Wet Sedge Meadow vegetation (0.5%). In the NPR-A portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (0.3%).	241 acres covered by gravel fill and mining, 2,116 acres altered by indirect impacts. In the Colville River Delta, the highest surface area impacts are to Wet Sedge Meadow Tundra vegetation (0.4%). In the NPR-A portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (0.1%).	For Sub-Alternative C-1: 409 acres covered by fill and mining, 3,647 acres altered by indirect impacts. In the Colville River Delta, the highest surface area impacts are to Wet Sedge Meadow Tundra vegetation (1.1%). In the NPR-A portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (0.4%). For Sub-Alternative C-2: 410 acres covered by gravel fill and mining, 3,695 altered by indirect impacts. The highest surface area impacts are to Tussock Tundra (0.5%) and Wet Sedge Meadow Tundra (0.2%).	For Sub-Alternative D-1: 272 acres covered by gravel fill and mining, 2,501 acres altered by indirect impacts. For Sub-Alternative D-2: 93 acres covered by gravel fill and mining, 784 acres altered by indirect impacts.	For Alternative F: 316 acres covered by gravel fill and mining, 3,150 acres altered by indirect impacts. In the Colville River Delta, the highest surface area impacts are to Wet Sedge Meadow Tundra vegetation (0.6%). In the NPR-A portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (0.3%).
SPILLS: Most very small to medium spills would have no to negligible effects on terrestrial vegetation and wetland habitats because these spills are generally confined to the gravel pads and roads. Large to VLVS spills to wetlands and tundra may affect the exposed habitats. Spills of oil and/or salt water may affect the tundra vegetation directly and/or the underlying soils, making the soils unsuitable for tundra vegetation survival. The impacts may persist longer for salt water than for oil, which weathers. The loss of vegetation as a result of spilled material and/or from cleanup actions may expose soil and underlying permafrost to thermokarsting as well as wind erosion processes. Saltwater spills may have a smaller impact in wetland and wet tundra habitats occupied by halophytic (salt-loving) plants than in habitats farther from the coast and the Colville River estuary. The impacts on wetlands and tundra habitats would generally be limited to the directly exposed areas and would not have regional-level impacts on the habitats or the resources that depend on these habitats.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that a VLVS may take longer to contain and clean up if it occurs when there is no ice road access, thus increasing the time that the spilled material may affect the vegetation and wetlands	**SPILLS:** Same as Alternative A.

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Biological: Terrestrial Vegetation and Wetlands (cont'd)</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Cumulative effects of past actions on vegetation have generally been minor. Impacts on the vegetation of Alaska's North Slope from the ASDP and past, present, and future oil and gas exploration and development in the Plan Area are expected to be additive with respect to the impacts, present and future, from other oil and gas activities outside the Plan Area. The affected area continues to be a very small fraction of the total North Slope acreage. It is not expected that synergistic impacts to vegetation would occur by affecting additional acres, nor would any effects (whether beneficial or adverse) occur to vegetation as a result of additional acres developed. In addition to oil and gas development projects that would directly affect North Slope vegetation, global climate change could alter the species composition.</td></tr>
<tr><th colspan="5">Biological: Fish</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td>Potential impacts to winter habitat and feeding and spawning areas include increased access to these areas by roads. Water withdrawal for ice road construction could create overcrowding and reduce dissolved oxygen in lakes, with fish mortality a possible result. Construction of ice roads or airstrips on fish overwintering areas could cause freezing to the bottom and block fish movement. Low dissolved oxygen could also result from suspension of oxygen-demanding materials during construction of the Nigliq Channel bridge. Bridge approaches at the Nigliq Channel and Ublutuoch River would extend into the floodplain terrace(s), altering flow and blocking fish passage during flood stage. The long network of roads could result in alteration of regional surface hydrology, including interruption of fish movements.</td><td>Because the road system of Alternative B would be shorter than that of Alternative A, impacts would be on a smaller scale. Vehicle bridges across the Nigliq Channel and Ublutuoch River would not be constructed. No facilities would within the 3-mile Fish Creek Buffer Zone.</td><td>Total water demands for Alternative C ice roads, and thus the potential for impact on fish, would be far greater than for Alternative A because the length of roads in Alternative C is greater than in Alternative A, and power lines in Alternative C do not parallel roads. The road to CD-3 could divert floodwaters to the east across the Delta, subjecting fish to altered hydrological conditions. In Alternative C-2: impacts of the pipeline-only bridge over the Nigliq Channel would be far less severe than those of the road and pipeline bridge in Sub-Alternative C-1; and ice road water demands would be greater than for Sub-Alternative C-1.</td><td>Construction impacts would be less than for Alternative A because no roads are proposed, and the pipeline crossing of the Nigliq Channel would be accomplished by HDD. Potential impacts to fish from ice roads would be greater than for Alternative A.</td><td>Similar to Alternative A except bridges at the Nigliq Channel and Ublutuoch River would span main channels and floodplains to the secondary terraces and therefore would have little effect on river flow during normal flood stages; potential impacts to Fish Creek drainage are reduced by substantially reducing lengths of road and pipeline within the 3-mile Fish Creek Buffer Zone; and potential fish passage impacts at Lake L9323 in Alternative A are mitigated by relocating the road to the east of the lake and crossing watercourses with bridges.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Biological: Fish (cont'd)</th></tr>
<tr><th>ALTERNATIVE A</th><th>ALTERNATIVE B</th><th>ALTERNATIVE C</th><th>ALTERNATIVE D</th><th>ALTERNATIVE F</th></tr>
<tr><td>SPILLS: Most very small to medium spills would have negligible or no impacts on fish or their habitat because these spills are generally confined to the gravel pads and roads. Large to VLVS spills to flowing waters or wetlands and tundra ponds/lakes may affect fish through increased toxicity levels, decreased dissolved oxygen concentrations in confined water bodies, and/or increasing salt concentrations in freshwater habitats. There may be indirect impacts on the fish through reduction or contamination of their food resources. Spills, especially of oil, that reach the Colville River Delta/Nigliq Channel estuarine areas may affect fish in these habitats. If the spills occur during the period when the rivers are ice-covered, the oil and/or salt water may affect the fish aggregated in deep pools. The impacts of spills on fish populations are likely to be localized and not cause regional population-level impacts. Even VLVSs are unlikely to affect the marine fish populations of Harrison Bay.</td><td>SPILLS: Same as Alternative A.</td><td>SPILLS: Same as Alternative A, except that likelihood of impacts to fish in the Colville River Delta/Nigliq Channel estuarine habitats may be less because the Nigliq Channel crossing is farther upstream than in other alternatives.</td><td>SPILLS: Same as Alternative A, except that likelihood of impacts on fish in the Nigliq Channel downstream of the HDD crossing during the ice-covered period may be greater if a slow, undetected leak from the buried pipeline into the ice-covered Nigliq Channel occurs and remains undetected for several weeks or months.</td><td>SPILLS: Same as Alternative A.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: The combined impacts on fish from the ASDP and other past, present, and future projects, while additive, are not expected to affect the viability of fish species or populations. Overall, cumulative impacts from blocking fish passage in North Slope freshwater habitats are and would be low to moderate under the proposed action. The cumulative impact of increased human access to fish populations (for example, along new roads and highways) is expected to be minor and additive. Wide-ranging increased impacts on arctic fish populations found on the North Slope would not be anticipated. Also, synergistic impacts to fish from disturbance are not anticipated.</td></tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Birds – Waterfowl and Loons				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Impacts on waterfowl and loons associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts resulting from lost productivity are not quantified by this analysis An estimated 77 waterfowl and 10 loon nests displaced by habitat loss, alteration, or disturbance. More displacement from habitat loss and alteration than from disturbance. Would reduce Plan Area nesting by 1% for waterfowl and <1% for loons.	An estimated 91 waterfowl and 9 loon nests displaced by habitat loss, alteration, or disturbance. More nests affected at CD-3 and CD-5 than other three sites. Would reduce Plan Area nesting by 2% for waterfowl and <1% for loons.	An estimated 78 and 81 waterfowl and 10 loon nests displaced by habitat loss, alteration, or disturbance for Sub-Alternatives C-1 and C-2. More nests affected at CD-3 and CD-5 than other three sites. Would reduce Plan Area nesting by 1% for waterfowl and <1% for loons. More displacement from habitat loss and alteration than from disturbance. Local access could affect amount of hunting mortality.	For Alternative D-1, an estimated 102 waterfowl and 12 loon nests displaced by habitat loss, alteration, or disturbance. For Alternative D-2, an estimated 38 waterfowl and 5 loon nests displaced by habitat loss, alteration, or disturbance. Would reduce Plan Area nesting by 2% for waterfowl and 1% for loons. More displacement would result from disturbance (70%) than from habitat loss and alteration. More potential disturbance at CD-3 and CD-5 than other three sites.	An estimated 79 waterfowl and 10 loon nests displaced by habitat loss, alteration, or disturbance. More displacement from habitat loss and alteration than from disturbance. Would reduce Plan Area nesting by 1% for waterfowl and <1% for loons. More nests affected at CD-3 and CD-5 than other three sites.
SPILLS: Most very small to medium spills would have no to negligible impacts on waterfowl and loons, including yellow-billed loons, or their habitat because these spills are generally confined to the gravel pads and roads. Large to VLVS spills to flowing waters or wetlands and tundra ponds/lakes may affect nesting waterfowl and loons. Spills of oil that reach the Colville River Delta/Nigliq Channel estuarine areas may affect pre-nesting, molting, and staging birds. The impacts may result from direct oiling, ingestion of oiled food, and secondary exposure of eggs and chicks through oiled parents. The impacts are not likely to be detectable at the population level.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except the likelihood of impacts on waterfowl and loons in the Colville River Delta/Nigliq Channel estuarine habitats may be less because the Nigliq Channel crossing is farther upstream than in other alternatives.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects on bird populations on the North Slope. It is expected that the effects on waterfowl and loon populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Increased harvests, especially from subsistence hunting, resulting from increased access to remote areas via new roads, could be a serious cumulative factor. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Birds – Ptarmigan				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
An estimated 3 ptarmigan nests would be displaced by habitat loss or alteration. Most impacts from habitat loss and mortality resulting from collisions with vehicles during winter and early spring when ptarmigan are attracted to roads for grit and early snowmelt. Adds 26 miles of roads for potential collisions. Local access to the NPR-A could affect amount of hunting mortality.	An estimated 5 ptarmigan nests displaced by habitat loss or alteration. Most impacts from habitat loss and mortality resulting from collisions with vehicles during winter and early spring when ptarmigan are attracted to roads for grit and early snowmelt. Adds 11 miles of roads for potential collisions.	An estimated 5 ptarmigan nests displaced by habitat loss or alteration (C-1 and C-2). Most impacts from habitat loss and mortality resulting from collisions with vehicles during winter and early spring when ptarmigan are attracted to roads for grit and early snowmelt. Adds 42 miles of roads for potential collisions. Local access to Colville River Delta and the NPR-A could affect amount of hunting mortality.	For Sub-Alternative D-1, an estimated 9 ptarmigan nests displaced by habitat loss or alteration. For Sub-Alternative D-2, an estimated 3 ptarmigan nests displaced. Most impacts from habitat loss and mortality resulting from collisions with vehicles during winter and early spring when ptarmigan are attracted to roads for grit and early snowmelt. These alternatives have no roads.	An estimated 4 ptarmigan nests displaced by habitat loss or alteration. Most impacts from habitat loss and mortality resulting from collisions with vehicles during winter and early spring when ptarmigan are attracted to roads for grit and early snowmelt. Adds 27 miles of roads for potential collisions.
SPILLS: Most very small to medium spills would have no to negligible impacts on ptarmigan or their habitat because these spills are generally confined to the gravel pads and roads. Impacts are unlikely unless larger spills flood over or spray on a nest site or on the food resources (insects and vegetation). Because of the low density of ptarmigan, only I or 2 nests or birds are likely to be affected even in a VLVS.				
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on ptarmigan populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Increased harvests, especially from subsistence hunting, resulting from increased access to remote areas via new roads, could be a serious cumulative factor. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				
Biological: Birds – Raptors and Owls				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Little chance of affecting nesting habitats for ground-nesting species because of low nesting densities. Towers, pipeline, and power lines would provide vantage. Most use of area during late summer when raptors forage in Delta on juvenile birds.	Same as CPAI Alternative A	Same as CPAI Alternative A Additional power lines may benefit raptors.	Same as CPAI Alternative A	Same as Alternative A
SPILLS: Most very small to medium spills would have no to negligible impacts on raptors or owls or their habitat because these spills are generally confined to the gravel pads and roads. No impacts on nests and nesting birds from larger spills unless the spilled material is sprayed over the tundra in areas where these birds tend to nest on elevated sites. There may be some impact on birds if their prey is living but oiled, or if they scavenge oiled dead prey.				
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on raptor and owl populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Birds – Shorebirds

ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D	ALTERNATIVE F
An estimated 346 shorebird nests displaced by habitat loss or alteration. More nests affected at CD-6 and CD-3 than for other three sites. Would reduce Plan Area nesting by <1% for shorebirds.	An estimated 232 shorebird nests displaced by habitat loss or alteration. More potential nests affected at CD-3 than for other four sites. Would reduce Plan Area nesting by <1% for shorebirds.	An estimated 525 (C-1) or 506 (C-2) shorebird nests displaced by habitat loss or alteration. More potential nests affected at CD-3 than for other four sites. Would reduce Plan Area nesting by 1% for shorebirds.	For Sub-Alternative D-1, an estimated 219 shorebird nests displaced by habitat loss or alteration. For Sub-Alternative D-2, an estimated 68 shorebird nests displaced by habitat loss or alteration. More nests affected at CD-3 and CD-4 than for other three sites. Would reduce Plan Area nesting by <1% (both D-1 and D-2).	An estimated 360 shorebird nests displaced by habitat loss or alteration. More nests affected at CD-6 and CD-3 than for other three sites. Would reduce Plan Area nesting by <1% for shorebirds.
SPILLS: Most very small to medium spills would have no to negligible impacts on shorebirds or their habitat because these spills are generally confined to the gravel pads and roads. Larger spills that are released to flowing water bodies or to flooded tundra and/or are sprayed into the atmosphere upwind of shorebird nesting habitat may affect local concentrations of nesting shorebirds. Large to VLVS spills to the rivers that transport the oil to the Colville River Delta/Nigliq Channel and Harrison Bay intertidal areas may affect staging shorebirds directly or their prey resources, resulting in potential local decreases in population size for the year.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that the likelihood of oil reaching the shorebirds' intertidal staging or tundra nesting habitat is somewhat lower because the Nigliq Channel crossing is farther upstream than in the other alternatives.	**SPILLS:** Same as Alternative A, expect that a VLVS may take longer to clean up if it occurs when there is no ice road access, thus increasing the time that spilled oil may affect birds.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on shorebird populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Birds – Seabirds (Gulls, Jaegers, and Terns)				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
An estimated 3 seabird nests displaced by habitat loss, alteration, or disturbance. More displacement resulting from habitat loss and alteration than from disturbance. Would reduce Plan Area nesting by 1% for seabirds.	An estimated 11 seabird nests displaced by habitat loss, alteration, or disturbance. More displacement resulting from disturbance than than habitat loss and alteration. Would reduce Plan Area nesting by 1% for seabirds.	An estimated 14 (C-1) or 15 (C-2) seabird nests displaced by habitat loss, alteration, or disturbance. More displacement resulting from habitat loss and alteration than from disturbance. Would reduce Plan Area nesting by 1% for seabirds.	For Sub-Alternative D-1, an estimated 14 seabird nests displaced by habitat loss, alteration, or disturbance. For Sub-Alternative D-2, an estimated 5 seabird nests displaced by habitat loss, alteration, or disturbance. Would reduce Plan Area nesting by 1% (D-1) or <1% (D-2). More displacement resulting from disturbance (70%) than from habitat loss and alteration.	An estimated 13 seabird nests displaced by habitat loss, alteration, or disturbance. More displacement resulting from habitat loss and alteration than from disturbance. Would reduce Plan Area nesting by 1% for seabirds.
SPILLS: Most very small to medium spills would have no to negligible impacts on seabirds or their habitat because these spills are generally confined to the gravel pads and roads. Large to VLVS to flowing waters, especially at flood stages, may affect wetland and tundra ponds/lakes used by nesting seabirds and waterfowl. Large and VLVS spills, mostly from pipelines to the major rivers may reach the Colville River Delta/Nigliq Channel estuarine habitats and Harrison Bay to potentially affect the habitat, prey resources, and/or the seabirds directly. The impacts are not likely to have local or regional population-level impacts.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that the likelihood of oil reaching the seabirds' habitat is somewhat lower because the Nigliq Channel crossing is farther upstream than in the other alternatives.	**SPILLS:** Same as Alternative A, expect that a VLVS may take longer to clean up if it occurs when there is no ice road access, thus increasing the time that spilled oil may affect birds.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on seabird populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Increased harvests, especially from subsistence hunting, resulting from increased access to remote areas via new roads, could be a serious cumulative factor. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Birds – Passerines				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
An estimated 206 passerine nests displaced by habitat loss or alteration. More nests affected at CD-6 than for other four sites. Would reduce Plan Area nesting by <1% for passerines.	An estimated 132 passerine nests displaced by habitat loss or alteration. More nests affected at CD-3 than at other four sites. Would reduce Plan Area nesting by <1% for passerines.	An estimated 305 (C-1) or 298 (C-2) passerine nests displaced by habitat loss or alteration. More potential nests affected at CD-3 and CD-6 than at other three sites. Would reduce Plan Area nesting by 1% (C-1 and C-2).	For Sub-Alternative D-1, an estimated 121 passerine nests displaced by habitat loss or alteration. For Sub-Alternative D-2, an estimated 38 passerine nests displaced by habitat loss or alteration. More potential nests affected at CD-3 and CD-4 than at other three sites. Would reduce Plan Area nesting by <1% (D-1 and D-2).	An estimated 215 passerine nests displaced by habitat loss or alteration. More nests affected at CD-6 than at other four sites. Would reduce Plan Area nesting by <1% for passerines.
SPILLS: Impacts are unlikely unless the spill floods over or sprays on a nest site or on the food resources, mostly insects and vegetation. Because of the relatively high density of passerines, especially lapland longspur, tens to hundreds of nests or birds may be affected, especially in a VLVS.				
CUMULATIVE IMPACTS: The additive impacts of past, present (including ASDP), and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on passerine populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Disturbance in conjunction with predators attracted to development areas such as common ravens and glaucous gulls may exacerbate reduced productivity as described by the NRC (2003).				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Terrestrial Mammals				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Alternative A would involve the changing of habitats used by terrestrial mammals in several ways. Approximately 241 acres of undeveloped lands that provide habitat for terrestrial mammals would be covered with gravel fill and 65 acres excavated to obtain gravel. Noise and human activity associated with construction, industry vehicle traffic, aircraft traffic, and activity on facilities and pipeline routes during operations may disturb caribou, moose, muskoxen, and grizzly bears in the vicinity of infrastructure. This may cause animals to move away from infrastructure (i.e., displacement). Pipelines will be elevated 5 feet and separated from roads by >300 feet. This should allow passage of caribou and other terrestrial mammals. The road/pipeline combination may delay or deflect caribou crossing, especially if traffic levels are >15 vehicles/hour. If local hunting occurs on the roads, crossing may be impeded because of increased avoidance of human activity. Impacts as described are relevant to individual animals. Hunting by local residents on the oilfield roads will increase the mortality of caribou and possibly moose, muskoxen, and grizzly bears. All of the impacts described above are relevant to individual animals. It is unlikely these impacts will have a negative impact at the population level.	Approximately 204 acres of undeveloped lands that provide habitat for terrestrial mammals will be covered with gravel fill and 37 acres excavated to obtain gravel. Disturbance, obstruction of movements, and mortality impacts will be of less magnitude than in Alternative A because of the smaller amount of road/pipeline combinations and associated lower levels of vehicle traffic. Disturbance and hunting mortality from local resident access will not occur since roads would be restricted to industry use.	Approximately 323 acres (C-1) and 324 acres (C-2) of undeveloped lands that provide habitat for terrestrial mammals would be covered with gravel fill and 86 acres excavated to obtain gravel (C-1 and C-2). Disturbance, obstruction of movements, and mortality impacts would be of greater magnitude than in Alternative A because of the larger amount of road/pipeline combinations and associated higher levels of vehicle traffic. Pipelines elevated to 7 feet would mitigate obstruction of movements. Disturbance and hunting mortality from local resident and other public access would occur. The potential impacts of hunting mortality described for Alternative A would occur to a greater extent in Alternative C because of the unrestricted public access.	Approximately 221 acres (D-1) and 71 acres (D-2) of undeveloped lands that provide habitat for terrestrial mammals would be covered with gravel fill and 51 acres (D-1) and 22 acres (D-2) excavated to obtain gravel. Disturbance, obstruction of movements, and mortality impacts would be of lesser magnitude than Alternative A because of the lack of road/pipeline combinations, associated vehicle traffic, and elevation of pipelines to 7 feet. Disturbance and obstruction of movement at airstrips or helipads would occur. Disturbance and hunting mortality from local resident access via roads would not occur because of the absence of roads.	Approximately 251 acres of undeveloped lands that provide habitat for terrestrial mammals would be covered with gravel fill and 65 acres excavated to obtain gravel. Disturbance, obstruction of movements, and mortality impacts would be comparable to Alternative A. Pipelines elevated to 7 feet would mitigate obstruction of movements.
SPILLS: Most very small to medium spills would have no to negligible impacts to terrestrial mammals or their habitat because these spills are generally confined to the gravel pads and roads. Large and VLVS spills, mostly from pipelines and especially those that spray into the atmosphere and/or occur when the tundra is flooded may affect the habitat, prey resources, and/or the terrestrial mammals directly. The impacts may affect the local populations for a few months to a few years, depending upon the distribution and abundance of the species and its reproductive cycles. There would not likely be a detectable local or regional population level impact. The larger mammals (e.g., bears, caribou, muskoxen, wolves, and foxes would likely leave the affected area to avoid the spilled oil and the presence of the response crews and equipment, thus reducing the potential levels of impacts to these animals.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Terrestrial Mammals (cont'd)

CUMULATIVE IMPACTS: Past, present, and reasonably foreseeable future activities, including the ASDP proposed development, are not expected to affect the viability of mammal populations. However, some populations may be reduced in number to such an extent as to have an adverse impact on subsistence users. Cumulatively, non-oil and gas activities and spills would have little impact on terrestrial mammals. Cumulative effects on caribou calving distribution are likely to be long term over the life of the oilfields, but would occur locally within 3 to 4 kilometers (1.8 to 2.5 miles) of roads or other facilities situated within calving areas. Cumulative impacts that would obstruct wildlife movements would be minor (USACE 1999), and synergistic effects at the herd level would not be anticipated. Cumulative oil development on the North Slope would likely result in increased abundance of arctic foxes near development areas. The cumulative effects on muskoxen, moose, wolves, wolverines, and small mammals from oil and gas development on the North Slope would be local and short term, within 1 to 2 miles of the exploration or development facilities, with no adverse effects on populations.

Biological: Marine Mammals

ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D	ALTERNATIVE F
Construction of, and traffic on, a bridge over the Nigliq Channel and other rivers could cause some disturbance of spotted seals and beluga whales. Aircraft traffic in and out of the Plan Area could also disturb some marine mammals. Construction and operational noise in winter could disturb some denning polar bears. Hunting by local residents on the oilfield roads could increase the mortality of polar bears that are onshore. All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative impact at the population level.	Limited roads, including no road over the Nigliq Channel, suggests there would be less disturbance from vehicles and more disturbance from aircraft traffic than in Alternative A. There would not be access by local residents, so increased hunting harvest would not occur.	Impacts to marine mammals under Alternative C (Sub-Alternatives C-1 and C-2) would be similar to those in Alternative A. The road accompanying the pipeline between CD-1 and CD-3 could increase disturbance in that area. The unrestricted access to BLM lands could result in greater polar bear mortality from road kills and defense of life and property kills. The pipeline only bridge over the Nigliq Channel with Sub-Alternative C-2 would reduce potential impacts (disturbance and hunter access) compared to Sub-Alternative C-1. The lack of road connection to CD-1, CD-2, CD-3, and CD-4 with Sub-Alternative C-2 would limit access to the northern Colville River Delta areas compared to Sub-Alternative C-1.	Alternative D would have minimal impacts on marine mammals because of the lack of roads and no local or public access. Noise from construction and increased air traffic could cause disturbance of marine mammals as described for Alternative A.	Construction of, and traffic on, a bridge over the Nigliq Channel and other rivers could cause some disturbance of spotted seals and beluga whales. Aircraft traffic in and out of the Plan Area could also disturb some marine mammals. Construction and operational noise in winter could disturb some denning polar bears. Hunting by local residents on the oilfield roads could increase the mortality of polar bears that are onshore. All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative impact at the population level.

SPILLS: There would be no impact from saltwater spills because the spilled material will be the same as the marine receiving waters. A VLVS of oil may reach the marine environment and expose some ringed and spotted seals or polar bears in Nigliq Channel, Harrison Bay, or the nearshore Beaufort Sea. The impact at the local population level would be minor. There would be little or no impact to populations of beluga whales because they are generally offshore beyond the likely distribution of the spilled oil. A few belugas may be affected if they are in the Colville River Delta or Nigliq Channel during an oil spill.

CUMULATIVE IMPACTS: Past, present, and reasonably foreseeable future activities, including the ASDP proposed development, are not expected to affect the viability of mammal populations. However, some populations may be reduced in number to such an extent as to have an adverse impact on subsistence users. Cumulatively, non-oil and gas activities and spills would have little impact on terrestrial mammals. Cumulative effects on caribou calving distribution are likely to be long term over the life of the oilfields, but would occur locally within 3 to 4 kilometers (1.8 to 2.5 miles) of roads or other facilities situated within calving areas. Cumulative impacts that would obstruct wildlife movements would be minor (USACE 1999), and synergistic effects at the herd level would not be anticipated. Cumulative oil development on the North Slope would likely result in increased abundance of arctic foxes near development areas. The cumulative effects on muskoxen, moose, wolves, wolverines, and small mammals from oil and gas development on the North Slope would be local and short term, within 1 to 2 miles of the exploration or development facilities, with no adverse effects on populations.

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

<table>
<tr><th colspan="5">Biological: Threatened and Endangered Species – Bowhead Whale</th></tr>
<tr><td colspan="5">ALL ACTION ALTERNATIVES</td></tr>
<tr><td colspan="5">Potential impacts would be limited to major spills. Bowhead whales generally do not occur in the nearshore Beaufort Sea, north of the Plan Area. During spring and fall migrations, bowheads are far offshore in the lead system of the Beaufort Sea.</td></tr>
<tr><td colspan="5">SPILLS: There would be no impact on bowhead whale individuals or populations as they are generally offshore beyond the likely distribution of the spilled oil.</td></tr>
<tr><td colspan="5">CUMULATIVE IMPACTS: Past, present, and reasonably foreseeable future oil and gas activities are not expected to cause cumulative impacts to bowhead whale populations. However, cumulative impacts may occur as a result of non-development activities such as approved hunting or loss/injury from encounters with fishing nets and vessels at sea.</td></tr>
<tr><th colspan="5">Biological: Threatened and Endangered Species – Spectacled Elder</th></tr>
<tr><td>ALTERNATIVE A</td><td>ALTERNATIVE B</td><td>ALTERNATIVE C</td><td>ALTERNATIVE D</td><td>ALTERNATIVE F</td></tr>
<tr>
<td>Impacts to spectacled eiders associated with construction and operation of Alternative A include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts from lost productivity are not quantified by this analysis.
An estimated 1.7 nests affected by habitat loss, alteration, and disturbance, reducing nesting by 4% for Plan Area spectacled eiders.
Less than 1% of available habitats in the Colville River Delta used by spectacled eiders for nesting (Aquatic Sedge with Deep Polygons and Nonpatterned and Patterned Wet Meadow) would be affected by gravel fill-related activities. Less than 1% of available habitats in the NPR-A used by spectacled eiders for nesting (Deep and Shallow Open Water with Islands, Old Basin Wetland Complex, and Patterned Wet Meadow would be affected. More nests would be affected at CD-3 than at the other four sites. Local road access could affect hunting mortality.</td>
<td>An estimated 1.9 nests affected by habitat loss, alteration, and disturbance, reducing nesting by 4% for Plan Area spectacled eiders.
More displacement resulting from disturbance than from habitat loss and alteration. <0.6% of available habitats in the Colville River Delta used by spectacled eiders would be affected by gravel fill-related activities. < 0.5% of available habitats in the NPR-A used by spectacled eiders would be affected. More nests affected at CD-3 than other four sites.</td>
<td>An estimated 0.9 nests affected by habitat loss, alteration, and disturbance, reducing nesting by 2% for Plan Area spectacled eiders.
More displacement resulting from habitat loss and alteration than from disturbance. <1.5% of available habitats in the Colville River Delta used by spectacled eiders would be affected. <0.5% of available habitats in the NPR-A used by spectacled eiders would be affected. More potential nests affected at CD-3 than other four sites.
Local access could affect amount of hunting mortality.</td>
<td>For Sub-Alternative D-1 an estimated 2 nests would be affected by habitat loss, alteration, and disturbance.
For Sub-Alternative D-2 an estimated 0.7 nests would be affected by habitat loss, alteration, and disturbance.
More displacement from disturbance (70%) than from habitat loss and alteration. <1% of available habitats in the Colville River Delta used by spectacled eiders would be affected. <0.5% of available habitats in the NPR-A used by spectacled eiders would be affected. More potential disturbance at CD-3 than other four sites.
Most displacement from disturbance in the Colville River Delta.</td>
<td>Impacts on spectacled eiders associated with construction and operation of Alternative F include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts of lost productivity are not quantified by this analysis.
An estimated 1.7 nests affected by habitat loss, alteration and disturbance, reducing nesting by 4% for Plan Area spectacled eiders.
More displacement from disturbance (53%) than from habitat loss and alteration. <0.7% of available habitats in the Colville River Delta used by spectacled eiders would be affected by gravel fill-related impacts. <0.6% of available habitats in the NPR-A used by spectacled eiders would be affected. More potential disturbance at CD-3 than other four sites.</td>
</tr>
</table>

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Biological: Threatened and Endangered Species – Spectacled Elder (cont'd)				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
SPILLS: A large to VLVS oil spill, most likely from a pipeline, may affect these birds in the Colville River Delta and Nigliq Channel areas as well as adjacent wetland habitats during their pre-nesting through staging activities. The likely exposure may result from pipeline spills between CD-1 and CD-3 and CD-4 as well as in the Nigliq Channel crossing (bridge or HDD). An oil spill that affects many to most of the nesting birds on the Colville River Delta may result in a detectable decrease in the local population size for a few generations.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that the amount of oil reaching the Colville River Delta habitat may be less from a spill at the Nigliq Channel crossing, which is farther upstream in both Sub-Alternatives C-1 and C-2.	**SPILLS:** Same as Alternative A, expect that a VLVS may take longer to clean up if it occurs when there is no ice road access, thus increasing the time that spilled oil may affect birds.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Some limited cumulative effects are anticipated for spectacled eiders, though these impacts are unlikely to produce significant population effects. The effects on spectacled eiders of various cumulative factors would likely be substantially greater than for any single activity or activities associated with any individual oil and gas lease sale. Disturbance of some individual eiders as a result of both onshore and offshore oil and gas operations would likely be unavoidable over the long term. The effects from typical activities associated with cumulative exploration and development of oil and gas prospects on the North Slope and adjacent marine areas may include small declines in local nesting or loss of small numbers of spectacled eiders, through disturbance effects on survival and productivity, predation pressure enhanced by human activities, and collisions with structures. Increased human access via new roads and highways may result in locally severe increases in subsistence hunting pressures. Alternatively, subsistence hunting may decrease if hunters avoid developed areas.				
Biological: Threatened and Endangered Species – Steller's Elder				
ALL ACTION ALTERNATIVES				
Potential impacts to Steller's eider generally are the same as those described for the spectacled eider. The likelihood of impacts occurring to Steller's eider would be very small because they occur very rarely in the Plan Area. There would be a loss of potential Steller's eider habitat from the Plan Area.				
SPILLS: Oil spills are unlikely to affect these birds because they are rare in the area and those periodically present are a small portion of the population. There would be no population-level impacts even if one to a few birds were exposed to an oil spill.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that the amount of oil reaching the Colville River Delta habitat and thus impacts to the eiders may be less from a spill at the Nigliq Channel crossing. which is farther upstream in both C-1 and C-2 than in other alternatives.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Some limited cumulative effects are anticipated for eiders, though these impacts are unlikely to produce significant population effects. The effects on Steller's eiders of various cumulative factors would likely be substantially greater than for any single activity or activities associated with any individual oil and gas lease sale. Disturbance of some individual eiders as a result of both onshore and offshore oil and gas operations would likely be unavoidable over the long term. The effects from typical activities associated with cumulative exploration and development of oil and gas prospects on the North Slope and adjacent marine areas may include small declines in local nesting or potential loss of small numbers of Steller's eiders, through disturbance effects on survival and productivity, predation pressure enhanced by human activities, and collisions with structures. Increased human access via new roads and highways may result in locally severe increases in subsistence hunting pressures. Alternatively, subsistence hunting may decrease if hunters avoid developed areas.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Socio-Cultural				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Potential impacts on subsistence harvest and use could cause stress and change in community social organization in the village of Nuiqsut and to a lesser degree in Barrow, Atqasuk, and Anatuvuk Pass. To the extent that changes in community social organization occur, changes in community health and welfare could also occur. Economic benefits are expected to occur as a result of Kuukpik and other corporate participation in construction and operations contracting. Minimal employment during construction and operation of village residents is expected. No change in the population growth rate is expected.	Same as Alternative A with the exception of a potential for reduced economic benefits.	Same as Alternative A; exceptions are the potential for increased local economic benefits and increased indirect community health and welfare impacts to the extent that they are caused by increased impacts to the subsistence harvest (resulting from connecting Nuiqsut to the project road system).	Same as Alternative A; exceptions are changes in impacts related to subsistence harvest that could result from the general elimination of roads in the Plan Area.	Same as Alternative A; exceptions are lesser negative effects on subsistence harvest resulting from pipelines elevated to 7 feet and removal of road segments from Fish Creek Buffer Area.
SPILLS: Most very small to medium spills would have no to negligible impacts on socio-cultural characteristics of the North Slope communities. Large to VLVSs may cause social and cultural impacts if there is a substantial influx of people (mostly non-Alaska Natives), resources, and services from non-North Slope locations to conduct spill containment and cleanup operations. Subsistence harvest activities may be disrupted by the response as well as the spill itself, depending upon where and when it occurs relative to the timing and location of subsistence hunting and fishing activities (see Subsistence Harvest below).				
CUMULATIVE IMPACTS: Overall, both additive and synergistic impacts to the socio-cultural characteristics of North Slope communities associated with the ASDP and past, present, and reasonably foreseeable future development may occur. Changes to community structure, cultural values, and community health and welfare predate oil and gas development on the North Slope; however, change in community socio-cultural characteristics has continued during the period of oil development. As the area affected by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass are currently dependent on subsistence caribou harvest from the CAH and TLH; additional future development may have additive impacts on subsistence harvest from these herds, leading to synergistic impacts on subsistence-harvest patterns (including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources), social bonds, and cultural values.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Regional Economy				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Would provide an annual incremental increase in federal, state, and local tax revenues. This increase would be on the order of 2% to 4% (of 2001 revenues) for the NSB. It would be less than 1% of state tax revenues. NSB and villages would receive benefits from increased economic activity in the region, increased opportunity for grants under the NPR-A Impact Mitigation Program, and from direct employment of local residents. Could be adverse economic impacts on subsistence harvesting activities resulting from increased travel costs and increased travel times.	Same as Alternative A except that potential reduction of between 10 and 30 percent in production from CD-6 caused by moving the production pad outside the 3-mile Fish Creek Buffer Zone. Results in an overall reduction of 4.2% of the total production from CD-3 through CD-7. The economic benefits from Alternative B would be reduced by this factor.	Same as Alternative A, though a road connection to Nuiqsut could facilitate greater employment for local residents.	Same as Alternative A	Same as Alternative A.
SPILLS: Most very small to medium spills would have no to negligible impacts on the local or regional economy. A large to VLVS may generate enough additional temporary employment for cleanup activities to temporarily affect the local and regional Alaska Native economy. The influx of people and demand for services may create a temporary economic strain on the local service providers. An oil spill, likely from the pipeline from CD-3 to CD-1, may affect the Helmericks' commercial fishing operations in the Colville River Delta.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A, except that the amount of oil reaching the Colville River Delta habitat and thus impacts to the eiders may be less from a spill at the Nigliq Channel crossing, which is farther upstream in both C-1 and C-2 than in other alternatives. This may result in less potential impact to the Helmericks' commercial fishing operations, most of which are not near the Nigliq Channel.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Even with the ASDP and other past, present, and reasonably foreseeable activities considered, the oil industry in and near Prudhoe Bay is anticipated to decline over time. This decline would encompass oil exploration, development, and production and its associated direct employment. Associated indirect employment in Southcentral Alaska, Fairbanks, and the NSB and revenues to the federal, state, and NSB governments are also anticipated to decline. The regional economic effects generally would decline corresponding to the decline in production. The ASDP would generate the following average annual revenues for the period 2007 to 2020: $7 million to the NSB; $40 million to the state; and $17 million to the federal government. In total, the cumulative case would generate the following additive average annual revenues: $7 million to the NSB; $66 million to the state; $114 million to the federal government.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Subsistence Harvest and Uses				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Construction and operation of facilities and roads would affect availability of key subsistence resources by deflection or displacement of these resources from customary harvest locations. Access to subsistence resources would be affected by the perception of regulatory barriers, the reluctance to hunt and shoot firearms near industrial facilities, including pipelines, raised road berms, pipelines with snowdrifts in winter that hinders passage, and a preference for animals not habituated to industrial development. Indirect effects would include hunters who go to another area that would result in increased effort, cost, and risks associated with traveling farther. The location of a production facility, pads, roads, and pipelines within the area of Fish and Judy creeks would result in infrastructure close to important subsistence use areas for Nuiqsut.	Moving CD-6 and associated roads outside the 3-mile Fish Creek Buffer Zone and elimination of the Nigliq Channel road bridge would decrease potential impacts to subsistence uses in the area; other impacts would be the same as those in Alternative A.	In addition to impacts of Alternative A, roads and pipelines would be located closer to Nuiqsut. The road connecting Nuiqsut to the development area would provide increased vehicle access to subsistence resources, resulting in increased competition for subsistence resources if more hunters are focused to the roads. At the same time, vehicular traffic on the roads would result in local deflection/disturbance of terrestrial mammals in the vicinity of the roads, and thus reduce availability of subsistence resources. Unrestricted road access to BLM lands would eventually provide increased access to people who do not live in the area and may increase competition for resources.	Similar impact to Alternative A with the exception of less year-round road traffic to affect resource availability and increased air traffic and ice road traffic that could deflect or divert subsistence resources in high traffic areas. Seven-foot pipeline clearance would be less restrictive to movement by subsistence users.	Moving road segments outside the 3-mile Fish Creek Buffer Zone would decrease potential impacts to subsistence uses in the area. A pipeline clearance of 7 feet would be less restrictive to movement by subsistence users. Other impacts would be similar to Alternative A.

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Subsistence Harvest and Uses (cont'd)				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
SPILLS: Most oil spills are very small to medium, confined to pads and roads, and would not affect subsistence resources or the harvest and use of these resources. Large to VLVS spills that reach the tundra and/or water bodies may affect subsistence resources (e.g., certain species of plants, fish, birds, and mammals). The impacts to the resources themselves are generally limited to the local area of the spill and would not have detectable regional population-level effects. However, subsistence harvest and use of these resources may be affected over a larger area and for several years. The Alaska Natives' traditional knowledge may guide their harvests and uses more strongly than the technical information from government agencies that the resources are safe for people to use. The impact to local and regional subsistence users may vary depending upon the spilled material, resources affected, and alternative areas or types of resources.	**SPILLS:** Same as Alternative A, except that the access to subsistence resources may be somewhat limited compared to Alternative A because there are no roads from CD-1 to CD-6.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative B, except that there are no gravel roads for the subsistence users to use for access to use areas.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from non-subsistence hunters for fish and wildlife (Haynes and Pedersen 1989). Additive impacts that could affect subsistence resources include potential oil spills, seismic noise, road and air traffic disturbance, and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Based on potential cumulative, long-term displacement and/or functional loss, habitat available for caribou may be reduced or unavailable or undesirable for use. Changes in population distribution because of the presence of oilfield facilities or activities may affect availability for subsistence harvest in traditional subsistence use areas of the communities of Barrow, Atqasuk, Nuiqsut, and Anaktuvuk Pass. Overall, impacts to subsistence harvest and use may have synergistic impacts with community health, welfare, and social structure. To the extent that subsistence hunting success is reduced in traditional use areas near communities because of the presence of oilfield facilities and activities, subsistence hunters will need to travel to more distant areas to harvest sufficient resources to meet community needs. Greater reliance on more distant subsistence use areas will result in greater time spent away from the community for some household members and competition for resources with members of other communities. These changes in subsistence patterns may result in stress within households, family groups, and the community.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Environmental Justice				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Disproportionate impacts to minority populations include potential direct and indirect impacts related to subsistence harvest and use. Other impacts identified as potentially disproportionate include spill impacts and potential water quality, air quality, and aircraft noise impacts.	Same as Alternative A	Same as Alternative A, except relaxation of access restrictions that would increase public access to BLM lands and may increase competition for subsistence resources.	Same as Alternative A, except reduction in the use of roads between facilities incorporated in Alternative D could reduce the potential for impacts to subsistence harvest in Nuiqsut traditional use areas. However, increased use of aircraft to serve these facilities could have some limited offsetting noise impacts.	Same as Alternative A.
SPILLS: Spills could affect water quality and wildlife, resulting in negative impacts to subsistence harvest for Environmental Justice populations.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Environmental Justice effects on Inupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices. Potential effects would focus on the Inupiat communities of Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass. Development as contemplated in the cumulative case could cause long-term displacement and/or functional loss of habitat to CAH, TLH, and WAH caribou over the life of proposed development. This could result in a significant impact on access to, and perhaps the availability of, this important subsistence resource. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Access to subsistence-hunting areas and subsistence resources and the use of subsistence resources could change if oil development were to reduce the availability of resources or alter their distribution patterns. Any potential effects on subsistence resources and subsistence harvests would be expected to be mitigated, though not eliminated.				

Social Systems: Cultural Resources				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Cultural resources are situated in the vicinity of the production pads, the road/pipeline ROW, and the ASRC Mine Site. Construction of project facilities or pads within 1/4 mile of a cultural resource could result in direct effects including damage to or destruction of the resource The integrity of subsurface, surface, and aboveground cultural resources could be affected by construction activities. One cultural resource (TLUIHAR-082) is less than 1/4 mile from the CD-4 production pad, and one cultural resource (HAR-055) is less than 1/4 mile from the ASRC Mine Site.	Same as Alternative A, though less risk of impacts to unknown resources because less gravel will be excavated	Same as Alternative A, though more risk of impacts on unknown resources because more gravel will be excavated	Same as Alternative A, except the absence of roads would eliminate potential impacts on cultural resources associated with road construction, and there would be less risk of impacts on unknown resources because less gravel will be excavated.	Same as Alternative A.
SPILLS: Most oil spills are very small to medium, confined to pads and roads, and would not affect cultural resources. Most cultural resources have been identified before development of the CPAI Development Plan and the location of physical facilities have been planned to avoid impacts to the cultural resources. Thus, most large to VLVSs would not impact known cultural resources. A large to VLVS spill, especially of oil, that is sprayed into the atmosphere and carried downwind or that occurs during a flooding event may be dispersed over the tundra and/or water bodies to affect cultural resources some distance from the spill site. These spills may affect the cultural resource(s) for a few months to a few years, depending upon the persistence of the spilled material and the type of resource exposed.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Cultural Resources (cont'd)				
CUMULATIVE IMPACTS: The cumulative effects of the ASDP and other reasonably foreseeable future development, which include disturbance impacts from oil and gas exploration and the Colville River Road, would be expected to affect cultural resources to some degree. These impacts would be additive. Because of the nature of cultural deposits (that is, their generally unpredictable location and context—on surface or near surface), the magnitude of the impact is difficult to estimate. However, it is expected that if current procedures for survey and inventory before exploration and development activities were to be continued, the effect on the resource would be minimal. Before any ground-disturbing activity, industry would be required to evaluate and assess possible cultural resources in the immediate areas of the proposed disturbances.				
Social Systems: Land Use and Coastal Management				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Would result in nearly tripling the total number of acres developed for oil production within the ASDP Area. Construction of CD-6 and associated roads and pipeline requires wavier of BLM stipulation for development within Fish Creek Buffer Zone. Rezoning of land under the NSB LMRs from Conservation to Resource Development would be required.	Would result in an approximate doubling of the total number of acres developed for oil production within the ASDP Area. All facilities and construction will occur outside the Fish Creek Buffer Zone. Rezoning of land under the NSB LMRs from Conservation to Resource Development would be required.	Same as Alternative A, except that it would nearly quadruple the total number of acres developed for oil production within the ASDP Area.	The increase in the total number of acres developed would be less than that of other alternatives because of the absence of roads. Construction of CD-6 and associated roads and pipeline requires wavier of BLM stipulation for development within Fish Creek Buffer Zone. Rezoning of land under the NSB LMRs from Conservation to Resource Development would be required.	The total number of acres developed would be nearly the same as Alternative A.
SPILLS: Most oil spills are very small to medium, confined to pads and roads, and would not affect land uses or coastal zone management policies and regulations. Large to VLVSs may affect the habitats and resources as well as land uses of tundra and water bodies exposed to the spilled material, especially oil. Most of the land use impacts would be localized to the directly exposed area and would last for a few months to a few years, depending upon the persistence of the spilled material. There would not be long term, really extensive impacts to land uses or coastal zone management policies.				
CUMULATIVE IMPACTS: Additive cumulative impacts on land use, habitats, and subsistence on the North Slope would be expected to occur from current and future development and operation of energy, transportation, and utility facilities. The continued development of previously undisturbed areas on the North Slope will change the character of land use, cause increases in noise and disturbance, and potentially adversely affect habitats and subsistence. Most of the cumulative impacts from future development are likely to be localized to the widely dispersed facilities. Long-term impacts on land use and coastal resources are expected to be decreased effectively through stipulations, existing regulations and management practices, coordination, and through future permitting processes including federal, state, and local processes and regulations.				
Social Systems: Recreation				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
There would be no more than local adverse effects to the lightly used recreational resources of the plan area. Recreational opportunities in the Plan Area would remain consistent with the BLM's SPM classification.	Same as Alternative A	Same as Alternative A, though it may increase recreational opportunities for local residents.	Same as Alternative A	Same as Alternative A.
SPILLS: Most oil spills are very small to small, confined to pads and roads, and would not be noticed by people other than industry and local residents. The impacts of these spills on recreational activities would be negligible. Large to VLVS oil spills, especially those that reach tundra or flowing and/or large water bodies, may be visible from roads, elevated areas, or the air. There may be a limited impact on the few recreational users in the spill area, though ground access to these areas is likely to be limited by the response crews for safety reasons.				
CUMULATIVE IMPACTS: Short-term impacts, such as green trails and disturbance from noise and other activities, would not accumulate. Impacts from long-term or permanent facilities such as roads, pipelines, and gravel pads would accumulate and would result in the long-term loss of solitude, quietude, naturalness, or primitive/unconfined recreation, and wilderness-type values. These impacts could be locally adverse to recreational experiences.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Visual				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
Construction and operation would result in adverse effects on visual resources. Facilities and structures associated with operation would introduce contrast to the natural landscape. The presence of drill rigs, pipelines communication towers, and aerial power lines would be the most noticeable effect of construction. Other activities such as pad and road construction would have negligible impacts because the construction activities would occur in winter when viewer sensitivity is not an issue.	High contrasts, but slightly less than Alternative A because of buried power lines, removing need for power poles, and because facilities associated with CD-6 would be moved away from Fish Creek.	High contrasts would be greater than Alternative A because of extensive use of aerial power lines. Additional contrasts would occur from vehicular traffic and fugitive dust along the road that would connect to Nuiqsut.	High contrasts the same as Alternative A.	High contrasts, but slightly less than Alternative A as a result of removing the need for power poles between CD-6 and CD-7, adoption of lighting restrictions, and because additional road segments would be moved away from Fish Creek.
SPILLS: Most oil spills are very small to small, confined to pads and roads, and not visible to people other than industry and local residents. The visual impacts of these spills would be negligible. Large to VLVS oil spills, especially those that reach tundra or flowing and/or large water bodies, may be visible from roads, elevated areas, or the air. There may be a limited impact on local residents and the few recreational users in the spill area.	**SPILLS:** Same as Alternative A, except that the number of viewpoints on roads would be reduced by the reduction in roads compared to Alternative A.	**SPILLS:** Same as Alternative A, except that the potential for spills to reach Fish Creek would be reduced by moving most of the pipelines and the roads out of the Fish Creek Buffer Zone. Also, there are even fewer miles of gravel roads then in Alternatives A or B.	**SPILLS:** Same as Alternative A, except that the number of viewpoints on roads would be eliminated by the lack of roads compared to Alternatives A and B.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Short-term impacts such as green trails would not accumulate and would naturally recover. Impacts from long-term or permanent facilities such as roads, pipelines, gravel pads, and pits would accumulate and would result in the long-term loss of scenic quality. Long-term impacts from future development with a possible life span of over 30 years would affect the visual resources for the North Slope. These impacts would be expected to be greatest within a half-mile radius of each developed site. Pipelines could be elevated above ground level. Except during construction and repair of pipelines, there would be no associated on-the-ground activity. Therefore, long-term impacts to visual resources from pipelines would be expected to be minimal beyond approximately a half mile.				

TABLE 2.7-1 COMPARISON OF IMPACTS AMONG ACTION ALTERNATIVES (CONT'D)

Social Systems: Transportation				
ALTERNATIVE A	**ALTERNATIVE B**	**ALTERNATIVE C**	**ALTERNATIVE D**	**ALTERNATIVE F**
No adverse effects on public roads or transportation systems. Adds 26 miles of new roads in study area. Use of project roads restricted to industry and local residents. Potential secondary effects on wildlife, subsistence, and recreation from increased access.	No adverse effects on public roads or transportation system. Adds 11 miles of new roads in study area. Project roads would be accessible to industry only. Lesser potential secondary effects on wildlife, subsistence, and recreation from increased access.	No adverse effects on public roads or transportation system. Adds 42 miles of new roads in study area for either Sub-Alternative C-1 or C-2. Unrestricted use of project roads on BLM lands, use by industry and local residents only on state and private lands. Greatest potential secondary effects on wildlife, subsistence, and recreation from increased access.	No adverse effects on public roads or transportation system. Adds 2 miles of new roads (Alternative D-1) in Plan Area for industry use only. Lowest potential secondary effects on wildlife, subsistence, and recreation from increased access.	No adverse effects on public roads or transportation system. Adds 27.5 miles of new roads in Plan Area. Project roads would be accessible to industry, government, and local residents
SPILLS: There would be no impacts from most very small to medium and many large spills because they are confined to the roads or pads. There may be an occasional effect on local residents and industry personnel traveling on the roads if a spill results from a vehicle accident and/or there are oil spill response equipment and support vehicles on the road. A VLVS may result in road closure that affects local residents and/or industry personnel, especially if there is a significant spill response activity mobilized from the roads and pads. The response activities may also use much of the airstrip space.	**SPILLS:** Same as Alternative A, except there are fewer miles of road to be affected. The reduction in amount of road may increase the time it takes to detect a spill, especially a medium to large one, from a pipeline because aerial monitoring may be more difficult, especially in low visibility conditions, than it may be from the road. Also, impacts may be greater in the roadless areas because mobilization of crews to control, contain, and clean up the spills may take longer than if road access was available. .	**SPILLS:** Same as Alternative A, except that mobilization of response crews and equipment from outside the Plan Area for a VLVS may be more rapid in Sub-Alternative C-2 than in any of the other alternatives.	**SPILLS:** Same as Alternative B, except there are almost no roads.	**SPILLS:** Same as Alternative A.
CUMULATIVE IMPACTS: Development of the ASDP along with continued oil and gas development throughout the North Slope will result in substantial increases in both road and air traffic levels throughout the North Slope, particularly on the central oil and gas transportation infrastructure in the Prudhoe Bay area. However, most of the transportation infrastructure on the North Slope is restricted to industry and local resident use and is currently operated at well below capacity. Despite the substantial increase in activity levels, the existing infrastructure, combined with the proposed roads and airstrips serving remote facilities, is expected to be sufficient to accommodate these increased demands for air and overland transportation. Therefore, there are not anticipated to be any adverse cumulative effects on transportation resources on the North Slope.				

2.8 INSPECTION AND MONITORING

Federal, state, and NSB agencies would inspect the construction and operation of any facilities that they permit. The BLM would inspect facilities on the lands it manages to ensure compliance with permit conditions. The other agencies have authority to inspect facilities regardless of land ownership.

The permits issued by the agencies may require specific resource monitoring to ensure that certain environmental protection is being achieved. Monitoring, for example, may measure the impacts of certain oil and gas activities to determine whether they are affecting a specific resource, such as eiders or caribou, in an adverse manner and assist in identifying means to mitigate the impact.

The BLM has asked the Research and Monitoring Team (RMT), formed to comply with the terms of the agency's Northeast National Petroleum Reserve-Alaska IAP/EIS completed in 1998 and currently operating under the sponsorship of the BLM-Alaska's Resource Advisory Committee, to help formulate a monitoring plan for oil and gas development in National Petroleum Reserve-Alaska. The RMT is composed of members with expertise in relevant resource and development issues and representing government (currently BLM, USGS, MMS, USFWS, DOE, State of Alaska, and NSB), academia (currently the University of Alaska Fairbanks), conservation organizations (currently the Audubon Society), industry (currently CPAI), and one member-at-large (currently Richard Glenn of ASRC).

2.9 NEED FOR FURTHER NEPA ANALYSIS

The ASDP EIS is expected to meet the BLM's obligations under NEPA for analysis of development of the five satellite pads and related oil facilities currently proposed by CPAI. The ASDP EIS is undertaken in cooperation with the USACE, USEPA, USCG**,** and State of Alaska to meet their needs for permitting actions related to the ASDP. If the EIS is deemed adequate for their permitting needs, then no further NEPA analysis would be required for federal permits for development of the applicant's proposed action consistent with the federal agencies' ROD.

Oil development in addition to that authorized in the federal ROD (Northeast National Petroleum Reserve-Alaska IAP/EIS ROD) related to CPAI's proposed action would require additional NEPA analysis to gain federal agency authorization. Development of new pads, pipelines, roads, airstrips, and other facilities would require additional NEPA analysis. Requests to conduct certain operational, maintenance, and repair activities, such as ice road construction or a request to operate a vehicle on the tundra, also would require additional NEPA analysis. Depending on the location and the future proposal's regulatory requirements, the BLM, USACE, USEPA**,** and/or USCG would conduct the appropriate NEPA analysis. That NEPA analysis could be an EIS or EA. An EA would be prepared for actions that are not anticipated to result in significant impacts. If significant impacts are expected or identified by an EA, the BLM would prepare an EIS. Future NEPA analysis may benefit from the analysis in the ASDP EIS, including the FFD analysis.

TABLE OF CONTENTS

Page

LIST OF TABLES

SECTION 3
DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 INTRODUCTION

3.1.1 Plan Area

The ASDP Area encompasses approximately 890,000 acres of federal, state, and private lands in the central Arctic Coastal Plain of Alaska's North Slope. This area includes the Colville River Delta and the portions of the Ublutuoch River, Judy Creek, Fish Creek, Kalikpik River, and Kogru River drainages in the easternmost part of the National Petroleum Reserve-Alaska. The village of Nuiqsut and Colville Village are the only permanent populated centers within the Plan Area. The existing oil production infrastructure includes APF-1 and sales pipeline and a gas line to Nuiqsut. The area studied in this EIS is generally bounded on the west by 152º30'0" west longitude, the south by 70º0'0" north latitude, the east by the Colville River, and the north by the Beaufort Sea Coast, as shown on Figure 1.1.1-1.

The Arctic Coastal Plain, extending from sea level south to approximately 600 feet in elevation is treeless, generally flat to gently rolling, and spotted with shallow lakes and ponds. The Plan Area lies within two different and complex hydrologic regimes, the Colville River Delta and the area west of it. The Delta area is relatively flat, tundra-covered terrain, with local relief produced by a complex network of lakes interspersed with low-lying ridges and channels, associated with the ephemeral and distributary nature of deltaic systems.

The area west of the Delta is characterized by a few dominant streams, such as Fish and Judy Creeks, and periglacial features associated with low relief and poor drainage, such as thaw-lakes, marshes, and polygon-patterned ground (BLM 1998a). This area drains into Harrison Bay and the Beaufort Sea through the Kalikpik and Kogru Rivers and through Fish Creek and its major tributaries—Judy Creek and the Ublutuoch River. It is dominated by ice wedge polygons covered by wet tundra that is treeless. Surface elevations in the area range from approximately 20 to 120 feet.

Water resources in the Plan Area consist largely of surfacewater streams, lakes, and ponds; groundwater is very limited. Climate and permafrost are the dominant factors limiting water availability (BLM 1998a). Surface water and groundwater resources are described in detail in Section 3.2.2.

3.1.2 Existing Infrastructure in the Plan Area

3.1.2.1 Nuiqsut and Colville Village

NUIQSUT

Nuiqsut is a second-class city of approximately 450 people situated along the west bank of the Nigliq Channel within the Colville River Delta, as shown on Figure 1.1.1-1. Nuiqsut encompasses approximately 9 square miles of land within the NSB and is approximately 20 miles south of the Beaufort Sea Coast and 8 miles southwest of APF-1 at CD-1.

Public utilities provide essential services to the residents. Nuiqsut has an airstrip and a complete road and street grid. Electricity and potable water delivery services are provided to residential homes and public buildings. The village recently completed a piped water and sewer delivery project. Financed by the NSB Capital Improvements Program, the project included a wastewater treatment plant and a water treatment plant with connections to all homes and buildings in Nuiqsut. Communication services include a local telephone network with long-distance capability and a cable television distribution system (PAI 2002a).

During construction of the original APF-1, a pipeline was constructed by the NSB that transports natural gas from APF-1 to Nuiqsut. The pipeline crosses approximately 13.7 miles—8.8 miles above ground and 4.9 miles buried—of land managed by the State of Alaska and Kuukpik Corporation (Joint Pipeline Office 2003).

A 4,300-foot airstrip owned and operated by the NSB serves Nuiqsut year-round. In addition, for as many as 5 months a year (commonly mid-December through April), Nuiqsut is connected to the road system. Since 1991, ice roads have connected the Colville River Delta to the Kuparuk and Prudhoe Bay road system. From there, access to Deadhorse and the Dalton Highway is possible (PAI 2002a). In addition, a spur road, historically constructed during different years by either CPAI or the NSB, connects the village of Nuiqsut to the ice road network for APF-1. Additional details about Nuiqsut are presented in Section 3.4.

COLVILLE VILLAGE

Colville Village is situated on the site of the Helmericks' family home on Anachlik Island, on the northeast side of the Colville River Delta. The site was established in the mid-1950s and consists of several homes, a lodge, an airstrip, aircraft hangars, warehouses, a barn, workshops, and other outbuildings. Additional details about Colville Village are presented in Section 3.4.

3.1.2.2 Existing Alpine Processing Facilities

The existing oil production infrastructure for APF-1 is on the Colville River Delta between the Nigliq and Sakoonang Channels and approximately 8 miles north of Nuiqsut. Production pads CD-1 and CD-2 (Figure 1.1.1-1) began oil production in November 2000 and 2001, respectively.

Infrastructure at the existing CD-1 production pad fully supports the ongoing drilling and production operations, including activities at the CD-2 site. Facilities and equipment currently installed include processing facilities, production wells, camp facilities, sanitation utilities (water and wastewater), a drilling mud plant, an airstrip, a maintenance complex, warehouse buildings, disposal wells, an emergency response center, communications, power generation, and various mobile equipment (Wiggin and Dotson 2002).

The CD-2 production pad is a satellite, approximately 3 miles to the west of CD-1. Access to the site is by a gravel road, of which approximately 5,000 feet (closest to CD-1) is coincident with the edge of the airstrip. Currently at CD-2, a temporary camp provides support for ongoing drilling operations.

Pipelines consist of a gathering pipeline that transports unprocessed produced oil and water from CD-2 to APF-1 at CD-1, a seawater line from the seawater treatment plan at Oliktok Point, a miscible injectant line between CD-1 and CD-2, and a 34-mile-long oil sales pipeline with a small diesel line from APF-1, connecting to the Kuparuk River oilfield. Pipelines are elevated above the tundra by VSMs, except at the main channel crossing of the Colville River, where approximately 4,300 feet of the oil sales pipeline was installed beneath the river channel using HDD. Entry and exit locations for the HDD segment of the pipeline are set back approximately 300 feet from the Colville River's banks.

3.1.2.3 Hazardous Materials

Hazardous materials and solid waste have been introduced into the Plan Area through activities associated with Department of Defense (DOD) facilities and oil and gas exploration prior to the development of the Colville River Unit. In addition, population centers in the area introduce, store, and maintain hazardous materials, hazardous waste, and solid waste. The following sections provide information on potential hazardous material sites within the Plan Area.

DEPARTMENT OF DEFENSE SITES

The Kogru Distant Early Warning (DEW) line station (Figure 3.1.2.3-1) is located near the Kogru River. It was built as part of a defensive advance warning radar system in the 1950s, and is one of 18 sites constructed across northern Alaska at approximately 50-mile intervals. The Kogru station is also known as POW-2, POW-B, and 2nd Point from Barrow. It was classified as an intermediate station and consisted of a single, five-module operation and living building, support facilities with Doppler-type radar fences, and a runway (OHM 2000).

The Kogru station was active from 1957 through 1963. Investigative and cleanup activities have been performed intermittently since 1985. Between 1995 and 1999, the following buildings were demolished: the shop building, radar tower, AST for fuel, fuel pump house, living and operations building, and warehouse. Approximately 525 cubic yards of soil contaminated by petroleum, oils, and lubricants (POL) were excavated and placed in 1-yard Supersacks. Waste streams were sampled for characterization and disposal options, and materials were removed and transported offsite for disposal. Materials removed included: soil contaminated by POL and polychlorinated byshenyl (PCBs), creosote-treated wood, lead-based paint chips, PCB-containing equipment (transformers and electrical equipment), and nonregulated demolition debris (OHM 2000). After removal actions were completed, the gravel pads were fertilized and seeded. According to the remediation report, current concerns at the site include additional debris and an exposed landfill.

A Naval Aritc Research Laboratory (NARL) remote research camp was located at Putu, which lies east of Nuiqsut near the west bank of the Colville River’s main channel. The site was used from the late 1950s to the 1970s. The building was removed and little evidence of the site remains (PAI 2002a).

OIL AND GAS EXPLORATION ACTIVITIES

Oil and gas exploration activities within the Plan Area have included winter seismic exploration surveys and oil and gas exploration drilling. Figure 3.1.2.3-1 shows the location of exploration wells within the Plan Area.

NAVY AND USGS EXPLORATION SITES

The Navy conducted oil and gas exploration activities in the National Petroleum Reserve-Alaska from 1944 through 1953. During that time, 44 test wells were drilled and three small oil fields were discovered—Umiat, Simpson, and Fish Creek (USGS professional paper 1399). One of the early Navy test wells is within the Plan Area; Fish Creek 1 was drilled in 1949.

Cleanup operations conducted by the USGS in 1981 indicated that Fish Creek 1 was used as a disposal site for stockpiled debris. Typically, disposal sites were stripped of tundra overburden, excavated, filled with stockpiled metal debris, and compacted. The sites were then backfilled with 2 feet or more of fill and covered with the stockpiled tundra overburden. Seed and fertilizer were spread at the Fish Creek 1 site.

A second period of exploration was conducted within the National Petroleum Reserve-Alaskafrom 1974 through 1982 by the Navy (1974 and 1975) and the USGS (1976 through 1982). During this period, 28 exploration wells were drilled and 14,770 line miles of seismic survey were collected and interpreted (USGS professional paper 1399). Typically, reserve pits and flare pits were used to contain drilling waste. (Reserve pits are no longer used on the North Slope.) Four exploration wells drilled during this period are within the Plan Area: Atigaru Point (1977), North Kalikpik (1978), South Harrison Bay (1977), and West Fish Creek (1977). These sites were included in the USGS cleanup and revegetation program between 1977 and 1979. The ADEC has approved closure of the inactive reserve pits for these four sites.

OTHER OIL AND GAS EXPLORATION SITES

Additional exploration wells have been drilled within and near the Plan Area at the locations shown on Figure 3.1.2.3-1. The earliest exploration well, Colville 1, was drilled east of the Plan Area in 1966 by Sinclair Oil and Gas. Subsequently, wells were drilled within the Plan Area by Gulf Oil Corporation, Texaco Inc., Amerada Hess Corp., ARCO Alaska Inc., CPAI, and Anadarko Petroleum Corporation.

OTHER HAZARDOUS MATERIALS AND SOLID WASTE WITHIN THE PLAN AREA

Established winter travel routes servicing North Slope communities and recreational trails cross the Plan Area. Fuel storage areas and inevitable small spills are likely along these corridors. Solid waste and human waste also could have been introduced into these corridors.

The facilities associated with the village of Nuiqsut are described in Section 3.1.2.1. A brief overview of potential hazardous materials associated with the village includes, but is not limited to, the following:

- Bulk fuel storage areas and fueling systems
- Home heating systems
- Transportation—all-terrain vehicles, snowmobiles, boats, airplanes, and automobiles
- Permitted Class III landfill
- Wastewater treatment plant
- PCBs within transformers and electrical equipment

3.2 PHYSICAL CHARACTERISTICS

3.2.1 Terrestrial Environment

3.2.1.1 Physiography

The North Slope of Alaska encompasses three physiographic provinces: the Arctic Coastal Plain, the Arctic Foothills, and the Brooks Range. The Plan Area extends approximately 40 miles inland from the coast and is situated entirely within the Arctic Coastal Plain province. The Arctic Coastal Plain rises gradually from sea level to a maximum elevation of roughly 600 feet, and is comprised of two distinct zones: tundra lowlands and coastal area (Figure 3.2.1.1-1).

TUNDRA LOWLANDS

Treeless periglacial features associated with flat topography, poor drainage and underlying permafrost characterize the tundra lowlands. Thaw-lakes and polygonal surface patterns on interlake ice wedges are the dominant terrain features (BLM and MMS 1998a). Ice wedges, which produce the polygonal surface patterns, progressively become larger as winter contraction fractures in the surface soils fill with water during the brief summer thawing period, then freeze again during winter. As this seasonal process repeats, the polygons grow and become the most recognizable surface features over the entire North Slope. Another prominent feature on the lowlands are scattered pingos, low mound-like features formed in the centers of drained lakes, as water-saturated soil freezes inward from the basin sides.

The Colville River is the dominant feature along the eastern boundary of the Plan Area, covering approximately 250 square miles. The river transitions from a meandering channel to a highly channelized delta discharging to the Beaufort Sea. The broad delta plain consists of a network of active and abandoned channels (oxbow lakes), separated by either tundra-vegetated or shallow water areas that form extensive wetland habitats.

Coastal lakes are frequently elongated perpendicular to the prevailing winds from the erosive action of eddy currents (BLM and MMS 1998a). The lakes become more rounded and generally smaller farther inland. Features providing relief are limited to riverbank bluffs (some hundreds of feet high near the Arctic Coastal Plains' southern border with the Arctic Foothills), and scattered pingos.

COASTAL ZONES

The coastal area along the Arctic Ocean is generally low and flat, and is frequently separated from the mainland by barrier islands and alongshore spits. These spits support little vegetation, and lagoons typically develop behind them. The coastal area extends approximately 8 to 20 miles offshore and includes the shallow inner waters of the Beaufort Sea continental shelf.

The coastline is subject to minor tidal fluctuations of about 1 foot. The shoreline is characterized primarily by fine-grained soils, which are prevalent in the eastern National Petroleum Reserve-Alaska. These soils erode more rapidly than coarse-grained material such as that on the beaches of the Chukchi Sea (BLM 1981). The shoreline characteristics (e.g. tidal flat, tundra cliff, sand beach, etc.) have been classified using the Environmental Sensitivity Index classification scheme developed by NOAA (Figures 3.2.1.1-2 and 3.2.1.1-3) (Research Planning, Inc., 2002).

The Beaufort Sea continental shelf is relatively narrow, extending for 35 to 50 miles offshore with depths up to 600 feet, before steeply dropping off into the Arctic Ocean Basin. The surface circulation of the Beaufort Sea is dominated by a clockwise gyre in the Arctic Ocean Basin. Currents along the coastline can be highly variable, moving easterly or westerly, depending primarily on local wind patterns (State of Alaska 1975).

The prevailing current places ocean ice against the coastline in the Plan Area for as long as 9 months of the year. Shipping is thus constrained to the summer season, typically from July through September. Even then, prevailing northeast winds and offshore currents can cause pack ice to block areas of the coastline for weeks.

3.2.1.2 Geology

The Plan Area is situated at the transition between two major geologic structures, the Colville Basin and the Barrow Arch (Figure 3.2.1.2-1). Formation of the Colville Basin, Barrow Arch, and the associated Brooks Range was initiated during mid-Cretaceous compression of the Arctic Alaska Plate, produced by rift-zone expansion in the marine basin bordering the plate to the north. The resulting deformation formed the Brooks Range thrust-fault belt and the foreland Colville Basin and Barrow Arch (Moore et al. 1994). Present day seismic activity and deformation of Quaternary sediment evidence the continuation of mountain building in the Brooks Range. Although Alaska is seismically active, the North Slope has not experienced an earthquake exceeding a magnitude of 5.3 since 1968 (http://www.giseis.alaska.edu).

The stratigraphic sequence within the Plan Area comprises Mississippian- to Quaternary-aged sediments ranging from 31,000 to 37,000 feet in thickness. Lithologies vary from marine limestones to marine and deltaic sands and shales (Gyrc 1985a) (Figure 3.2.1.2-2). Oil exploration on the North Slope has historically targeted hydrocarbon plays within the Ellesmerian sandstones along the crest of the Barrow Arch (Figure 3.2.1.2-3). However, the 1994 to 1995 discovery of the Alpine Field in a previously unrecognized Jurassic sandstone reservoir has redirected exploration efforts to the Beaufortian Sequence. The Beaufortian Sequence lies between drilling depths of 6,000–11,000 feet in the Plan Area, and consists of Kuparuk Sandstone, Jurassic Sandstones, and Middle Jurassic Simpson Sandstone (BLM 2003b). Plan Area bedrock is mantled by the Quaternary-aged unconsolidated sediments of the Gubik Formation. This formation is largely comprised of fluvial and glaciofluvial sediments but also includes ma-rine, eolian, and lacustrine components (Rawlinson 1993). Landforms on the Beaufort Coastal Plain are predominately formed by lacustrine processes; whereas the sculpting of Colville Delta landforms is predominantly accomplished by fluvial processes (Jorgenson et al. 2003a). The distribution of surface deposits in a section of the Plan Area is shown on Figure 3.2.1.2-4.

PETROLEUM POTENTIAL

Advancements in directional drilling technology, westward expansion of Prudhoe Bay infrastructure, and the probability of petroleum accumulations in area subsurface reservoirs have decreased the minimum field volume necessary for, and risk associated with, commercial oil field development in the Plan Area. A detailed review of past development and forecasting of future exploration is presented by the BLM (BLM and MMS 1998a, BLM 2003b).

The assessment of oil and gas resources requires integration of geological interpretations, seismic mapping, petrophysical evaluation of reservoir rocks, geochemical analyses of source rocks, predictions of source rock maturation expulsion and migration, and accumulation of hydrocarbons. Ultimately, economic factors, such as cost per barrel to produce the oil from the subsurface versus market price, determine the minimum reserve volume necessary for a commercial venture. However, statistical methods are useful for assessing the degree of uncertainty and/or subjectivity in geologic data evaluations, and are also useful for providing a risk analysis related to potential presence of oil and gas accumulations.

The potential for oil resources is reported as a range from the 5 percent probability of occurrence, which is physically possible, though highly unlikely, to the 95 percent probability of occurrence, which indicates a much smaller potential oil value, but is quite likely to occur. Where the range of resources is large, the mean value is reported.

Recoverable resources are assumed to exist in a number of pools or accumulations that are drilled and tested during exploration. A size rank for undiscovered pools shows a lognormal distribution. These pools can include oil, gas, mixed oil and gas, and condensate resources. They could also be distributed anywhere within the area analyzed. The analyzed area in this case is the 13.2 million acres that were also assessed as part of the Northwest National Petroleum Reserve-Alaska IAP/EIS, a recent planning effort of the BLM, and it includes all portions of the Plan Area within the National Petroleum Reserve-Alaska. The predominant exploration target of the ASDP across this area is the Beaufortian Barrow Arch East play. Statistical modeling predicts the existence of approximately 141 prospects in this play, distributed unevenly across the 13.2 million acres that were assessed. Approximately 11 of the 25 largest prospects are hypothesized to be oil pools; gas, condensate, and mixed pools compose the others.

Current geologic analyses by the BLM suggest that the northernmost portion of the National Petroleum Reserve-Alaska, along the Barrow Arch, has the highest potential for oil and gas resources. This area of high geologic potential comprises approximately 1.87 million acres.

Of the approximately 1.87 million acres that have high geologic potential for oil and gas resources, approximately 1.51 million acres are close enough to existing infrastructure and have sufficient volumes of modeled resources in discrete prospects (or accumulations) to have economic potential. Of this total, approximately 680,000 acres are in the Plan Area west of the Nigliq Channel. The BLM does not have data to adequately model the Plan Area east of the Nigliq Channel. The mean resource value in the Plan Area can be apportioned as a fraction of the entire area with high economic potential. There could be a pool larger than the Alpine Field in the 1.51 million acres. As modeled, subsidiary pools would be smaller than the Alpine Field and would reflect a lognormal distribution. The size distribution for individual pools, however, might not be proportionately distributed geographically. Larger pools could be disproportionately under- or over-represented in the Plan Area. Statistically, there is no inference that the largest, or any of the larger, pool sizes may be present in the Plan Area.

Geologic and geophysical mapping identify numerous potential prospects for exploration. These efforts show that the discrete prospects are not evenly distributed across the northern National Petroleum Reserve-Alaska or the Plan Area. The small prospects lack sufficient reserves to offset development costs. The mapping also shows that prospects occur at different stratigraphic levels. Some prospects overlie one another, a placement that is economically fortuitous because it creates potential for multiple exploration targets to be developed from a single surface facility.

At oil prices of $30/bbl, statistical modeling conducted by the BLM as part of its Northwest National Petroleum Reserve-Alaska IAP/EIS, which also covers the Plan Area, suggests as many as 16 prospects may occur in the 1.51 million acres with sufficient oil accumulations to be economically viable. Apportioning these hypothetical hydrocarbon accumulations across the 1.51 million acres of the northern National Petroleum Reserve-Alaska, places seven of the theoretical prospects within the portion of the Plan Area that is coincident with the Northeast National Petroleum Reserve-Alaska area. Considering a success scenario for the seven modeled hydrocarbon accumulations, up to four pads may be required and developed in addition to the three proposed by CPAI (CD-5, CD-6, and CD-7). Finally, in the statistically unlikely case in which a hydrocarbon pool in this area contains more than 100 million barrels (MMbbl) of oil reserves, utilization of two production pads to recover the oil maybe necessary.

The possibility may exist with state leases within the northeast Colville River area for further discoveries of oil accumulations in the range of 40 to 50 MMbbl, similar to the low API gravity oil found at CD-3 and CD-4. If an economically feasible method of extracting the heavy oil can be determined, then two additional production pads on these state lands may be developed.

3.2.1.3 Permafrost

The Plan Area is located in a zone of laterally continuous permafrost. Ground within this zone has remained at or below 32°F for at least two consecutive years. The active layer above permafrost ground is subject to freeze thaw cycles. Maximum thaw depths (recorded at an active layer monitoring station proximal to the Fish Creek test well) (Figure 3.2.1.2-4) ranged from 11.02–11.81 inches over a 4 year period (1998 to 2001) (http://www.geography.uc.edu/~kenhinke/CALM/sites.html). Active layer thickness measured from 1987 to 1992 on a transect extending approximately 40 miles south from Prudhoe Bay increased from a coastal minimum of 8.3 inches to an inland maximum of 2.4 feet (Romanovsky and Osterkamp 1995). The depth of permafrost at the West Fish Creek #1 Borehole (Figure 3.2.1.2-4) in 1977 was 879.26 feet below the ground surface. Below this depth, geothermal heat precludes maintenance of permanently frozen ground. Mean annual permafrost temperatures measured in the Prudhoe Bay area over seven years (1986 to 1992) ranged from 19.8°F to 15.6°F (Romanovsky and Osterkamp 1995). Recent permafrost warming of 1.1°F (1987 to 1998) at inland sites and 2.7°F (1988 to 1998) at coastal sites on the Arctic Coastal Plain, and melting of wedge ice in the Plan Area is attributed to both high latitude warming and increased snowcover (Steiglitz et al. 2003, Jorgenson et al. 2003).

Permafrost is sensitive to changes in both climate and terrain. Natural or human actions that alter the local thermal conductivity and heat capacity of the active layer will change the permafrost condition. Climatic cooling, maturation of vegetation, increased surface reflectivity (albedo), and decrease in snow cover decrease heat flux to the subsurface and allows permafrost to increase in thickness and/or areal extent. Landforms associated with aggradation of ice-rich permafrost include ice wedge polygons and pingos. Alternatively, climatic warming, removal or compaction of overlying vegetation, mass wasting episodes and flooding will increase heat flux to the subsurface and allow permafrost to decrease in thickness and/or areal extent. Degradation of ice-rich permafrost is often accompanied by mechanical failure of previously frozen soils via solifluction, thermal erosion, thaw settlement, or collapse of the ground surface due to melting of massive ground ice, a phenomenon referred to as thermokarst (Lawson 1986, Lachenbruch and Marshall 1983). Inundation of thermokarst pits (Everett 1980) and infilling of low-lying margins of drained lake basins (Jorgenson et al. 2003d) can lead to development of primary and secondary thaw-lakes, respectively.

The degree and extent of thermokarst is related to the physical properties of sediment grain size, the volume and distribution of ground ice, and the topographic position of affected sediments (Walker et al. 1987). Organic and fine-grained mineral soils are generally poorly-drained and saturated. Upon freezing, the volume of ice generated exceeds the soil pore space volume, and tends to segregate as massive ice bodies such as vein, lenses, and wedge ice (NRC 2003). Wedge ice in the Plan Area occupies about 20 percent by volume of the landscape and is particularly vulnerable to melting because of its near surface position (Jorgenson et al. 2003d). Degradation of permafrost in ice-rich slits produces sediment with little or no strength that is highly susceptible to mechanical failure and hydraulic and thermal erosion. Alternatively, coarse-grained mineral soils are relatively well-drained and undersaturated. Because the volume of ice produced on freezing is accommodated by the pore space in coarse-grained deposits, degradation of permafrost in ice-poor units typically results in minimal and uniform thaw settlement. Moisture levels in well-drained soils are typically insufficient for thaw-lake development (Jorgenson et al. 2003d).

In a comparison of North Slope test well locations 30 years after disturbance, Lawson (1986) observed that removal of the vegetative mat overlying silty sediments with large amounts of ground ice at the East Oumalik test well site produced 9.8–16.4 feet of subsidence, compared to 1.3–6.6 feet of settlement in sandy materials with small amounts of ground ice at the Fish Creek test well site (Lawson 1982). As an extension of this investigation Lawson (1986) estimated ice-poor sediments require 5 to 10 years to regain stability whereas ice-rich sediments may require at least 30 years. If thermokarst creates impoundments or surface water flow, the heat absorbed by standing water and the mechanical action of flowing water will expand the lateral extent of subsidence. At the East Oumalik test well site, thermokarst covered twice the area of initial disturbance because thermal and hydraulic erosion had propagated the thawing of sediments (Lawson 1982). Studies conducted in a section of the Plan Area (Jorgenson et al. 1995, 2003d) estimated the potential mean thaw settlement for surface deposits, based on typical ice volumes and structures. Table 3.2.1-1 provides mean ice volumes and estimates of thaw settlement for deposits located in the portion of the Plan Area depicted on Figure 3.2.1.2-4 (coincident with the Northeast National Petroleum Reserve-Alaska area).

Potential thaw settlement estimates are lowest for eolian sand deposits (including both active and inactive deposits) because of their low ice volume and the uniform distribution of ice in the soil pore spaces. Thaw settlement estimates are also low for thaw basins, but because basin units are often located in depressions, even limited thaw settlement can lead to localized flooding and lateral expansion of permafrost degradation. The high volumes of ice present as near-surface ice wedges, or in ice-rich organic and silt layers in alluvial and abandoned overbank deposits, result in high estimates of potential mean thaw settlement for these units. However, alluvial and abandoned overbank deposits are not susceptible to river flooding due to their location outside the active floodplain (Jorgenson et al. 1995, 2003d). For this reason, water is not as likely to be impounded and propigate permafrost degradation.

TABLE 3.2.1-1 MEAN ICE VOLUMES AND POTENTIAL AMOUNTS OF THAW SETTLEMENT FOR GEOMORPHIC UNITS IN A SECTION OF THE PLAN

Geomorphic Deposit	Mean Ice	Potential Mean Thaw Settlement ±
alluvial marine and alluvial	71	1.67 ± 1.3
ice-rich thaw basin centers	66	0.89 ± 0.95
ice-rich thaw basin margins	62	0.62 ± 0.75
ice-poor thaw basin centers	59	0.72
ice-poor thaw basin margins	48	0.13 ± 0.16
eolian inactive sand	45	0.33 ± 0.23

3.2.1.4 Soils

Soil is the body of solids, liquids, and gasses at the land surface that is able to naturally support plant growth or has been visibly modified from its parent material. Two soil orders, Gelisols and Entisols are identified within the section of the Plan Area depicted on Figure 3.2.1.2-4. The unique property of Gelisols is the presence of permafrost and soil features associated with frost action. Entisols are dominated by mineral soil materials and distinct soil horizons are absent. Entisols are often located in areas of active erosion or deposition and thus do not experience the extended periods of stability necessary for modification by soil forming processes (NRCS 1999).

Soil order members are further categorized by soil class. Twenty-four soil classes are present in the section of the Plan Area depicted on Figure 3.2.1.2-4. Soils in this section of the Plan Area have not been fully classified and mapped using the current NRCS soil taxonomy. However, Table 3.2.1-2 presents the relative abundance of, descriptions of, landforms associated with, and susceptibility to frost deformation for the most commonly observed soil types.

TABLE 3.2.1-2 DESCRIPTION OF SOIL CLASSES OCCURRING IN THE PLAN AREA

Soil Order	Soil Class	% of Observations	Description	Associated Landform	Subject to Frost Deformation?
Gelisol	Typic Aquorthel	11.5	wet, fine-grained soil with thin organic layer	inactive overbank deposits	No
Gelisol	Typic Historthel	8.6	wet soil with thick organic layer	various	No
Entisol	Typic Cryptopsamment	8.0	sandy, well-drained soil	eolian sand deposits	No
Gelisol	Typic Aquiturbel	7.5	wet, fine-grained soil with thin organic layer	various	Yes
Gelisol	Typic Histoturbel	6.9	wet soil with thick organic layer	polygons, drained lake basins, terraces	Yes

The presence of permafrost is the dominant control on soil forming processes in the Arctic. Mechanical weathering of surface material in the Arctic is largely accomplished by repetitive freezing and thawing, and is therefore restricted to the transitional periods between winter and summer when diurnal freeze thaw cycles are active. Ice-rich permafrost acts as a barrier to infiltrating water and causes saturation of the overlying soil horizons. Cold and saturated soil conditions limit both biologic and chemical transformations in the active layer. Limited biological decomposition facilitates the accumulation of organic material as thick surface horizons; whereas limitations on chemical weathering restrict the availability of nutrients to tundra vegetation. Nutrients are further depleted from surface layers by infiltration of acidic precipitation and the subsequent leaching of cations (Everett 1979, Everett and Brown 1981). Reduction of iron and magnesium oxides is common in anoxic mineral horizons. Where saturation is uniform, reducing conditions lower the overall soil color, however, where saturation is spatially variable, neighboring zones of reduction and oxidation produce soil mottles (Ping et al. 1998). Variable moisture content in active layer soils is responsible for the differential change in soil volume on freezing, resulting in frost deformation of soil horizons, polygonal surface patterning, and incorporation of organic material at depth via cryoturbation. Localized soil expansion during active layer freezing is amplified by the migration of soil water to the freezing front. The temperature gradient set up during freezing induces water toward the freezing front, resulting in the formation of segregated ice bodies.

3.2.1.5 Sand and Gravel

A common denominator in nearly all oil and gas development is the need for granular mineral materials such as sand and gravel. These materials are used for construction of roads, pads, and airfields. On Alaska’s North Slope, the presence of permafrost creates special engineering and geotechnical problems affecting construction and maintenance of gravel infrastructure. The presence of large amounts of near-surface ice in the form of wedges, masses, and intergranular ice requires that development activity not disturb the thermal regime of the ground surface.

The surface materials of the Plan Area include marine silts, sands, and clays; beach and deltaic deposits; thaw-lake deposits; alluvium and fluvial-lacustrine deposits; eolian sands and upland silts; and sandstones and shales. Gravels are found specifically in active and inactive floodplains and low terraces (BLM 1998a). Because sand and gravel have economic value, BLM regulations (43 CFR 3600) provide for the sale of mineral materials defined generally as common varieties of sand, stone, gravel, clay, and other materials (BLM 1998a).

There was concern as early as 1974 (BLM 1998a) that in certain areas of the Arctic Coastal Plain, sand and gravel resources would become scarce. Roads in the Kuparuk River Unit (KRU) and Prudhoe Bay Unit (PBU) benefited from quality gravel sources that have been relatively inexpensive to develop. West of the Colville

River, however, the Plan Area is characterized by an apparent scarcity of suitable gravel for road, pad, and airstrip construction (PN&D 2002a).

GRAVEL MINE SITES

Existing and potential gravel sites within the Plan Area include the ASRC Mine Site and the Clover Potential Gravel Source (Figure 2.2.3-1). Use of these sites would require developing ice roads and pads to support mining and transportation of the gravel. Other gravel sites currently unknown could also be used for FFD.

ASRC MINE SITE

The ASRC Mine Site is approximately 9 miles southeast of CD-1, on the east side of the Colville River across from Nuiqsut (Figure 2.2.3-1). The site contains a low quality material, defined as sandy gravel to gravelly sand, with interbedded discontinuous layers of silt (PN&D 2002a).

The ASRC Mine Site is permitted (Department of the Army Permit: Colville River 17, 4-960869) and has an approved reclamation plan that would be revised before reopening the mine. The permitted area is 152.9 acres (67.0 acres for the Phase 1 permit area and 85.9 acres for the Phase 2 permit area). Phase 1 was developed in 1998 and 1999, with a total of approximately 1.03 million cubic yards of sand and gravel excavated and hauled for use by the Alpine Development Project (CD-1 and CD-2). Overburden soils were shot, hauled, and temporarily stockpiled outside the pit on ice pads. Before break-up each season, the stockpiled overburden was placed back into the pit area.

Ultimately, the 1998 and 1999 Phase 1 mining pits were developed as two lakes with adjoining canals, creating a 9-acre waterfowl nesting island. The lakes include 7.5 acres of very shallow littoral zones (less than 1.5 feet deep) and 10 acres of shallow littoral zones (6 feet to 1.5 feet deep) for wildlife habitat (TMA 2000). Monitoring of the reclamation plan is ongoing.

Estimated sand and gravel reserves for Phase 2 are 1.9 million to 2.5 million cubic yards (PN&D 2002c).

CLOVER POTENTIAL GRAVEL SOURCE

The Clover Potential Gravel Source is on the western edge of the Colville River Delta (Figure 2.2.3-1). The site was identified from exploratory well cuttings and was further investigated during the winter seasons of 2000–2001 and 2001–2002. Exploratory borings identified sandy gravel and gravelly sand beneath approximately 5 to 20 feet of overburden soils (silts and silty sands). The approximate footprint of the site is 65 acres (1,680 feet by 1,680 feet) (see Appendix O), and the quantity of sand and gravel resources is estimated at 2.5 million cubic yards. Development of the mine site would require a permit and reclamation plan (Appendix O).

3.2.1.6 Paleontological Resources

The paleontological record of the Plan Area ranges in age from the Paleozoic through Cenozoic. The record comprises fossils of both micro- and macro-organisms and plant remains, encompassing a variety of depositional environments from nonmarine to marine.

Fossils within the Plan Area are known from a total of at least 38 paleontological localities. Pleistocene fossils including mammoth, mastodon, horse, bison, muskox, caribou, lion, wolf, and bear are common throughout the area, most notably along the river drainages. From the late Cretaceous Prince Creek Formation, at least 25 localities have been reported, mostly in the Ocean Point area (Lindsay 1986, Gangloff 2002). Fossils in the Prince Creek Formation have been found ranging from 3 kilometers northwest of Ocean Point to 4 kilometers south of Kikak. These localities include dinosaur-rich bonebeds and microvertebrate sites documented thus far, and also include associated microflora. In particular, there have been reported findings of dinosaurs including Ceratopsidae, a small theropod, Hypsilophodontidae, Hadrosauridae, a pachycephalosaur, Troodontidae, Dromaeosauridae, and Ornithomimosauridae. Other vertebrate fossils found include tetrapod, theropod, and ornithopod dinosaur footprints, as well as mammals including Multituberculata, Placentalia, and Marsupalia. Various invertebrates including clams, and wood and plant fossil debris have also been found in the Prince Creek Formation of the Plan Area. (Lindsay 1986, Gangloff 2002).

In the Mesozoic/Cenozoic Schrader Bluff formation, one locality has been reported with bivalves, brachiopods, ostracodes, gastropods, and foraminifera (Lindsay 1986). In the Pliocene and later Pleistocene deposits, one locality has been reported in the Colville Formation with gastropods and pelecypods, eight localities in the Gubik Formation with a sea otter, seal, mollusks, gastropods, bivalve, and scallop, and six localities in unnamed formations with mammoths, musk oxen, mollusks, gastropods, pelecypods, ostracods, barnacles, and wood. (Lindsay 1986).

The Ocean Point site on the Colville River (Figure 3.1.2.3-1) within the Plan Area marks a globally-significant find of dinosaur fossils in upper Cretaceous strata. These fossils are notable in several respects. The specimens are well preserved by varying degrees of mineralization and have been subsequently entombed in permafrost. The combination of these preservation mechanisms allows extraction of biomolecular material previously unattainable in fossils of this age. Additionally, the Ocean Point fossils represent the northernmost occurrence of dinosaurs in North America (Gangloff 1998, Phillips 1990).

3.2.2 Aquatic Environment

3.2.2.1 Water Resources

CLIMATIC FACTORS

Snowmelt and ground blizzards are two primary climatic factors that influence the hydrologic balance in the Plan Area and on the North Slope in general. A little more than half the total annual precipitation occurs as snow (USDA 1996). Snowmelt contributes the majority of the annual runoff and helps maintain a saturated layer of surface soils. Prevailing winds blow cold air off the largely frozen Arctic Ocean, often creating blizzard conditions with drifting and compacted snow (Sloan 1987). These ground blizzards redistribute the snow based on minor terrain features and exposures.

Low amounts of precipitation occur throughout the summers that are interspersed with heavier rainstorms usually in the foothills during July and August. Summers, which are short and relatively cool near the coast, can be somewhat longer and warmer inland. Freeze-up usually begins first on the Arctic Coastal Plain and then proceeds southward toward the foothills. Because winters are long, most small streams and shallow lakes are frozen to the bottom much of the year. Streams in the Plan Area are fed by runoff and have no flow during winter (except perhaps the Colville River, which may flow under ice during the winter in some years), limiting available water to the deeper pools and stream reaches. The onset of snowmelt and the subsequent runoff often begins earlier in the foothills and moves north as the summer season progresses (BLM and MMR 1998a).

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years (Lynch, et al, 2003). These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic. The Office of Naval Research, U.S. Arctic Research Commission (2004) report that although there is considerable debate over predicted changes in Arctic climate patterns due to global warming, one likely scenario it that over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing.

SUBSURFACE WATER (GROUNDWATER)

Subsurface water resources are controlled by their general proximity to large surface water bodies (including lakes, streams, and rivers) and by association with permafrost. In general, usable subsurface water in the Plan Area is limited to distinct and unconnected (isolated) shallow zones. This limited availability is due to the presence of permafrost, which is an almost continuous zone throughout the North Slope (Williams 1970).

The frozen state of the soils combined with fine-grained and saturated conditions form a confining layer that prevents percolation and recharge from surface water sources, and movement of groundwater. Such restrictions are reflected in the number of lakes and other poorly-drained areas that dominate the Coastal Plain Area. Because percolation and recharge are restricted, the formation of usable subsurface water resources is limited to: unfrozen supra-permafrost material or taliks (thawed zones) beneath relatively deep lakes, or hyporheic zones in thawed sediments below major rivers and streams. In the Plan Area, shallow supra-permafrost water also occurs seasonally within the active zone above the impervious permafrost. The thickness of the active layer is typically 1.5 feet, but ranges from 1 foot under dense organic mats, to 4 feet in coarse-textured soil (Rawlinson 1993, Gyrc 1985).

Usable deep subsurface water is limited to those reserves with acceptable water quality. Groundwater within permafrost or beneath permafrost zones (from 700 to 2,165 feet-deep on the North Slope) (Rawlinson 1993) tends to be brackish or highly saline. The origin of the poor water quality is unknown but is usually thought to be either connate water or inherited from one or more of the marine transgressions of the Pleistocene. The poor water quality existing in the subpermafrost aquifers is a strong indicator of little connection between supra-permafrost and subpermafrost water.

SHALLOW SUBSURFACE WATER

Larger lakes with depths greater than approximately 6 to 7 feet generally do not freeze to the bottom in the winter, allowing an unfrozen zone, or talik, to remain beneath the lake (Sloan 1987). Walker (1983) has theorized that a discontinuous, thawed hyporheic zone exists beneath the Colville River Delta due to irregular water depths in the area, changes in channel morphology across the delta, and heterogeneity in the channel sediments. Some of these theorized hyporheic zones in the prodelta or “delta fringe” area would likely have high salinity due to their proximity to the Beaufort Sea.

The thawed hyporheic zone below the Colville River, or the taliks associated with larger lakes, could be suitable for pumping water when the channel-bottom or lake-bottom sediments consist of porous materials, such as sands or gravels. For example, during construction of the TAPS, shallow water wells (galleries) were installed in the bed of the Sagavanirktok River. Although those wells in the lower river generally provided adequate supply, others in the upper river did not. Nelson and Munter (1990) describe thawed zones beneath deep river pools of arctic rivers as a series of discrete units separated by permafrost barriers. Apparently, the barriers resulted from the riverbed freezing below shallow riffles, which suggested that the water supply was directly related to the size of the pool in the river (Sloan 1987).

In general, while these shallow groundwater zones do exist, they are typically very small relative to those in more temperate systems, and there would likely be no difference between using the “shallow subsurface” waters and the lake or river water. Galleries or off-channel sumps are used to provide a mechanism to withdraw water at higher rates than possible, using screened intakes placed in-channel. However, their purpose is not to provide a “shallow-subsurface” water source during winter (B. Morris 2003).

GROUNDWATER WITHIN PERMAFROST

Groundwater within permafrost or intra-permafrost water occurs in discontinuous confined locations, where often the presence of dissolved salts depresses the freezing point of the water. The saline quality of the groundwater makes it unsuitable for drinking water and potentially harmful to vegetation if it’s discharged on the tundra surface. The usability of this type of groundwater source is likely to be limited because of the nature of its formation.

DEEP GROUNDWATER

Deep wells drilled through the permafrost in the vicinity of Prudhoe Bay have encountered highly mineralized groundwater at depths of 3,000 to more than 5,000 feet, but little data on deepwater sources in the Plan Area exist (Sloan 1987, BLM 1998a). Although there are no water well data in the area, geophysical data suggest that the depth to the base of permafrost and subpermafrost water could be significantly shallower in the Plan Area. On the basis of knowledge about Prudhoe Bay wells and other regional studies, groundwater in the Plan Area beneath the permafrost, or subpermafrost water, is likely brackish to saline (Williams and Van Everdingen 1973) and, therefore, not a usable water resource for surface placement or human consumption. However, it may be used for deep-well injections for disposal or reservoir maintenance.

RECHARGE

Snowmelt provides the major source of water for recharge to the shallow water-bearing zones that occur below large lakes and major streams, and to the annual thaw zones that occur beneath the ponds and marshy areas of the Colville River Delta. Deeper groundwater zones beneath the permafrost, however, are not as readily recharged. Subpermafrost water could be recharged from areas to the south in the Arctic Foothills and the Brooks Range and has a much longer residence time in the ground. It is also possible that the subpermafrost water could represent stagnant and/or isolated water zones that were cut off from recharge and groundwater movement as a result of the formation of permafrost during the Pleistocene, or that were isolated by orogenic events associated with the formation of the Brooks Range.

SPRINGS

Landsat imagery analysis located numerous groundwater springs on the North Slope by identifying the large overflow icings (aufeis) created downstream during the winter. However, none of these springs were located in the Plan Area (Sloan 1987).

LAKE HYDROLOGY

Lakes and ponds are the most prevalent features of the Plan Area (Figure 3.2.2.1-1). Unlike streams, which have large volumes of water present during break-up or the odd storm surge, some of the larger lakes have readily available year-round water (Sloan 1987). Availability of year-round water is determined by the depth of the lake. Those lakes with water depths greater than 6 to 7 feet generally will have free water under ice during the winter season.

In general, the melting of ice-rich permafrost can cause surface subsidence, often creating thaw-lakes, ponds, or beaded stream channels. Sellman et al. (1975) concluded that most lakes and ponds on the Arctic Coastal Plain originated from thawing the shallowest, ice-rich permafrost layer. They found that in permafrost near the coast, the upper 10 to 12 feet contained as much as 80 percent segregated ice. Disturbance of the vegetation or water and wind erosion could initiate melting of the upper ice-rich zones and trigger the development of thaw-lakes.

Recharge of lakes in the Plan Area occurs through three mechanisms: melting of winter snow accumulations within a lake drainage basin, over-bank flooding from nearby streams, and rainfall precipitation. Based on results of lake recharge investigations conducted on lakes within and outside the Delta, it appears that arctic lakes are typically recharged to above bankfull on an annual basis. Recharge from snowmelt or overland flow or a combination of both are the dominant recharge mechanisms (Michael Baker Jr. Inc. 2002e).

Shallow lakes and ponds (less than 6 to 7 feet deep) dominate the Arctic Coastal Plain in the Plan Area. The water temperature generally mimics ambient air temperature with a lag time related to lake volume (i.e. thermal mass). While river temperatures in the Plan Area have been documented at 62ºF, some shallow clear arctic lakes have been documented to reach summer temperatures as high as 68ºF (BLM 1998a). These lakes, if connected to a stream, provide extremely valuable rearing and feeding habitat for fish. The shallow lakes and ponds begin freezing up in September and freeze to the bottom by mid-winter. They become ice-free in late June or early July, approximately one month earlier than the deep lakes (Walker 1983).

Deep lakes (greater than 6 to 7 feet deep) with relatively large areas extend throughout the southern and western regions of the Plan Area. Some exhibit complex geomorphologic shoreline features (e.g., bays, spits, lagoons, islands, and beaches, as well as extensive shoal areas) and provide diverse ecological habitats, such as an over-wintering area for fish and aquatic invertebrates. These large lakes also provide the most readily available winter water supply. Lakes with a surface area greater than 10 acres cover approximately 16 percent of the Colville River Delta. These larger lakes are generally 11–15 feet deep, but can exceed 30 feet. Because they have a large thermal mass, the lakes remain covered by ice into early July, much later than the smaller lakes (Walker et al. 1978).

The physical characteristics of seven representative lakes in the Plan Area are summarized in Table 3.2.2-1. These lakes were selected as study lakes for the Alpine Lakes Recharge Study because they are typical of lakes suitable for water supply lakes in the Alpine Development Project area. Detailed descriptions and compilations of data and physical characteristics on more than 200 lakes in the Plan Area are contained in MJM Research (2000a and 2000b). The lake depth data from these studies are presented on Figure 3.2.2-1.

TABLE 3.2.2-1 PHYSICAL CHARACTERISTICS OF RECHARGE STUDY LAKES IN THE PLAN AREA

Lake Number	Estimated Volume (million gallons)	Area (acres)	Maximum Depth (feet)
L9312	300	100	14
L9313	160	69	12
L9310	211	61	24
L9282	1800	480	28
L9342	65	25	12
L9283	76	74	10
L9275	730	376	18

Note: Lake data provided by CPAI in Michael Baker Jr. Inc. (2002e).

RECENT LAKE STUDIES

Ongoing and future oilfield activities within the Plan Area would use ice roads and pads for access and transportation during the winter. Each season, millions of gallons of fresh water are withdrawn from regional lakes to construct ice roads and pads. Water withdrawals for construction could begin as early as December and continue through April. The ice roads are usually completed by mid-winter. However, water withdrawals for ice road and pad maintenance continue throughout the exploration season. In addition to ice road and pad construction, freshwater lakes are used as potable water supplies for temporary rig and exploration camps and as sources of make-up water for exploratory drilling operations (Michael Baker Jr. Inc. 2002e).

Recently, a number of studies focusing on lakes in the Plan Area were conducted. These include a Reanier & Associates (2000) study for Phillips Alaska, Inc. (PAI) which consisted of measuring lake volume (from surface area and bathymetry data) and in situ water quality parameters for 32 lakes identified as potential water sources for ice road and pad construction.

MJM Research (2000a, 2000b and 2001) conducted surveys of over 93 lakes in the eastern National Petroleum Reserve-Alaska within the Plan Area and additional 109 lakes within the Colville River Delta. During the surveys, the researchers measured fish abundance, lake cross-sections, lake bathymetry and general water quality parameters. From the physical data, researchers reported maximum lake depths and calculated lake volumes, including the maximum extractable or permitable volume. As of January 27, 2000, 30 percent of the water below a presumed 7 feet of ice cover may be extracted. Prior to this date, 15 percent of the water was permitted for extraction.

MJM Research (2003) extensively monitored two lakes in the Plan Area. Researchers investigated the effect of water withdrawal on water chemistry and fish populations by measuring fish abundance, lake area and bathymetry, water temperature, pH, specific conductivity, and turbidity. Over a 5-year study period, withdrawals generally did not affect water chemistry, nor did they directly affect fish populations. However, population of slimy sculpin in Lake L9312 has shown a continuous decline since sampling began in 1999.

Two lake investigations specifically dealing with over-winter water use and lake recharge were conducted during the winter of 2000–2001. The programs were initiated by BPXA and PAI and developed in coordination with the BLM. Both studies sought to investigate whether winter water withdrawals had a measurable effect on water quality, and to quantify water surface elevation changes caused by pumping. The BPXA study concluded within the limitations of the methodology used, that there was little evidence that water quality changed as a result of pumping. The study further suggested that water surface elevation changes in pumped lakes were within the range of changes seen in reference lakes, and that changes in water surface elevations were correlated with changes in ice thickness (Oasis 2001).

The winter of 2000–2001 PAI study was designed to monitor water levels and water quality at both pump and reference lakes, determine the amount of free water under the ice, and assess the amount of recharge to the lakes in the summer. Withdrawal rates were typically well below the maximum allowable. The PAI study concluded that water level decreases caused by pumping did not advance the freezing rate of the study lakes, and that water levels depressed by pumping returned to pre-pump levels before freeze-up. In view of in situ and analytical water quality results, the study concluded that pumping did not appear to cause significant degradation of water quality in the study lakes (Michael Baker Jr. Inc. 2002e).

Michael Baker Jr. Inc. (2002e) conducted monitoring and recharge studies of several lakes in the Alpine Development Project area and the surrounding Plan Area. The studies were designed to evaluate the magnitude and impacts of water withdrawn for ice road and pad construction during exploration activities at these lakes. The studied lakes included five pump lakes: L9911, L9817, M9912, M9922, and M9923; and four reference lakes: L9807, L9823, M0024, and M9914. Site visits were conducted so that lake conditions during pre-pump, post-pump, post-break-up, and pre-freeze-up periods were measured. The investigators concluded that water surface elevations in the majority of pump lakes were lowered more than in reference lakes, most likely due to pumping. The dominant mechanism for recharge of the lakes was melting winter snow accumulations within the drainage basin of each lake. Data from 2001 and 2002 studies as well as anecdotal information at seven North Slope communities (including Nuiqsut) indicate that the magnitude of spring recharge has always been sufficient to compensate for withdrawals (Michael Baker Jr. Inc. 2002e).

With respect to the lakes’ water quality, pumping did not appear to affect temperature, pH, turbidity, sulfate, and nitrate levels did not appear. In pump lakes where a water circulator was employed, average post-pump dissolved oxygen concentrations were higher than in reference lakes. Naturally occurring seasonal changes in water quality are a characteristic of North Slope Coastal Plain lakes. Seasonal water chemistry changes are likely influenced by the proportion of under-ice water volume to open-water lake volume. It is expected that pumping will have a greater impact on water chemistry in shallow lakes than it would in deep lakes, provided the lakes are similar in size and that the volume removed is comparable. However, broad regional generalizations regarding lake chemistry and lake chemistry changes due to seasonality and water withdrawal should be avoided (Michael Baker Jr. Inc. 2002e).

STREAM AND RIVER HYDROLOGY

DRAINAGES IN THE PLAN AREA

The Plan Area is dominated by the Colville River Drainage Basin, the largest river on the North Slope. Smaller waterways within the region include Fish Creek and the Kogru and Kalikpik Rivers. Also within the Plan Area are Judy Creek and the Ublutuoch River, which are major tributaries of Fish Creek (Figure 3.2.2.1-2). A summary of general hydrologic data for the major drainages within the Plan Area is provided in Table 3.2.2-2.

TABLE 3.2.2-2 SUMMARY OF GENERAL HYDROLOGIC DATA OR DRAINAGES IN THE PLAN AREA

Stream or Channel	Tributary to	Mean Elevation (feet msl)	Drainage Area (mi^2)	Number of Lakes (Proportion of Drainage as Lake Area)
Colville River Nigliq Channel East Channel	Harrison Bay	NA	20,920	NA
Kogru River	Harrison Bay	NA	NA	NA
Kalikpik River		110	431	107 (25%)
Fish Creek	Harrison Bay	134	1,827	116 (22%)
Ublutuoch River	Fish Creek	114	248	20 (15%)
Judy Creek	Fish Creek	196	666	92 (18%)
Inigok Creek	Fish Creek	186	270	57 (21%)
Kikakrorak River[1]	Colville River	310	379	17 (4%)
Kogosukruk River[1]		402	543	5 (1%)

Sources: BLM 1998a and URS Corporation 2003

Notes: [1]The Kikakrorak and Kogusukruk Rivers are tributaries of the Colville River, immediately south of the Plan Area.

Colville River

The Colville River is the longest river (370 miles) and has the largest drainage basin (20,920 square miles) on the North Slope of Alaska. The drainage basin extends from the Brooks Range to the Arctic Ocean (Jorgenson et al. 1996). Flow in the Colville River is controlled by some large tributaries that are outside the Plan Area and head in either the Brooks Range or the Foothills. These include the Etivluk, Anaktuvuk, Chandler, and Killik Rivers in the upper basin, and the Kogosukruk, Kikakrorak, and Itkillik Rivers in the lower basin. The last three rivers join the Colville River approximately 28 and 24 miles southwest and only 4 miles southeast of the village of Nuiqsut, respectively. The Itkillik enters the Colville River just upstream and south of the head of the Colville River Delta.

Colville River Delta

The Colville River Delta is more than 25 miles-long and covers approximately 250 square miles (Jorgenson et al. 1994) or approximately 1.2 percent of the entire Colville River Drainage Basin. The head of the Colville River Delta is the downstream most point where the river flows in a single channel. It is located a short distance downstream from the Itkillik River confluence.

Most of the water reaching the Delta is carried to the ocean through two main channels: the East (or Main) Channel and the Nigliq Channel. The East Channel is significantly larger than the Nigliq Channel and also distributes into a number of smaller channels, including the Sakoonang, Tamayayak, Elaktoveach, Kupigruak and Ulamnigiaq Channels (Figure 3.2.2.1-3). From infrequent observations made before 1967, Arnborg et al. (1967) estimated that approximately 80 percent of the annual discharge at the head of the Delta flowed into the East Channel and its distributaries, and the remaining 20 percent flowed into the Nigliq Channel. More recently, Jorgenson et al. (1996) reported that 38 percent of the peak flow discharge in 1995 (i.e., 233,000 cfs) was in the Nigliq Channel. In contrast, Michael Baker, Jr. Inc. (2004) reported that during the 2003 peak discharge estimated at 350,000 cfs only about 17 percent of this flow was estimated to be in the Nigliq Channel, and during a July 2004 low flow of 17,100 cfs only 650 cfs (or 3.8%) was measured in the Nigliq Channel (R. Kemnitz, 2004).

While detailed studies of the proportions of flow in the various channels across the Delta have not been made, it is evident that the proportion between the Nigliq and East Channels changes throughout the year, especially when ice jams occur during break-up near the entrance to these channels (Walker, 1982; Michael Baker, 2004d). During high flows, the Nigliq and other minor channels may carry much more than 20 percent, while as was evident in July 2004 during low water summer months the proportional flow in the Nigliq Channel can be much less than that amount. The proportion of flows in the East and Nigliq Channels is also not constant over the long-term because the geometry of channel conditions continues to evolve as a result of natural erosion and sedimentation processes in the Delta.

In general, the channels of the Colville River Delta are braided and broad and have high width-to-depth ratios. The East Channel is approximately 3,000 feet-wide, with depths ranging from 15 to 25 feet (measured from typical summer water surfaces) but as little as 10 feet and exceeding 40 feet at a few locations (Ray and Aldrich 1996). The Nigliq Channel is approximately 1,000 feet-wide and 10 to 30 feet-deep (Walker 1983, Ray and Aldrich 1996). Maximum depths are approximately 40 feet. The Sakoonang, Tamayayak and Ulamnigiaq Channels are narrower, on the order of 200 and 500 feet, respectively. The deepest parts of those channels approach 30 feet (Ray and Aldrich 1996).

Fish Creek Basin

Much of the Plan Area lies within the lower portions of the Fish Creek Basin (Figure 3.2.2.1-2). Fish Creek flows northeast and enters Harrison Bay just west of the Colville River Delta. The drainage basin is relatively large (1,827 square miles) with portions of its headwaters in the Arctic Foothills, as well as the Arctic Coastal Plain. Twenty-two percent of the basin is covered with lakes (URS Corporation 2003). The Fish Creek Basin consists of three significant tributary basins: Inigok Creek (270 square miles), Judy Creek (666 square miles), and Ublutuoch River (248 square miles) (URS Corporation 2003). Only the Judy Creek Basin has a significant portion of its headwaters in the Arctic Foothills (BLM 1998a). During flood stage in lower Fish Creek, one main (east) channel and a minor (west) channel with multiple other distributary channels are pathways for the river to Harrison Bay.

Judy Creek and the Ublutuoch River enter Fish Creek approximately 26 and 10 miles, respectively, upstream from its mouth (URS Corporation 2003). Because a portion of the Judy Creek headwaters originate at a higher elevation in the Brooks Range than those of other streams, Judy Creek tends to break-up first (URS Corporation 2001, BLM 2001). Portions of the Ublutuoch River are entrenched, which creates narrower floodplains and steeper riverbanks (BLM 2001).

The Fish Creek Basin streams have relatively low gradients and highly sinuous channels over at least the lower half of their stream courses. The Fish Creek and Judy Creek Channels' banks and beds consist of sand and silt-sized material. Undercut stream banks and bank sloughing are common along the outside of meander bends (URS Corporation 2003). Sand dunes form along portions of Fish and Judy Creeks (BLM 2001). In contrast to Fish and Judy Creeks, the Ublutuoch River Channel is incised within relatively steep upper banks that are vegetated with dense brush (BLM 1998a).

Kalikpik and Kogru River Basins

The Kalikpik and Kogru Rivers cross the northwest portion of the Plan Area only in the region considered for FFD (Figure 3.2.2.1-2). Information about these streams is limited to general physiographic information. The Kogru River is a relatively small riverine estuary, located at sea level, and was formed by coalescing thaw-lakes associated with coastal erosion and rising sea level during the Holocene. The Kalikpik River Basin (431 square miles) borders the Fish Creek Basin to the south, and its overall drainage patterns, lake density (25 percent), and northeast flow directions are similar to those of the lower Fish Creek Basin. No hydrologic data are available for the Kogru and Kalikpik Rivers.

RIVER DISCHARGE PROCESSES

Although hydrologic data for North Slope streams are sparse, all streams for which data are available share distinctive stream flow characteristics. Flow typically is nonexistent or at least not measurable through much of the winter. Stream flow begins in late May or early June as a rapid flood event termed “break-up.” Combined with ice and snow damming, break-up can inundate extremely large areas in a matter of days. More than half of the annual discharge for a stream can occur during a period of several days to a few weeks during break-up (Sloan 1987). Most streams continue to flow throughout the summer but at relatively low discharges. Rainstorms can increase stream water levels to the point that fish in shallow lakes with minor stream connections are not stranded over winter. Stream flow ceases at most streams shortly after freeze-up in September.

Long-term continuous discharge data are generally not available for streams in the Plan Area, including the Colville River, its channels, and the Fish Creek Basin streams. However, long-term hydrographic data exist for streams to the east that have similar size and physiography as some of the Plan Area drainages. One such drainage is the Kuparuk River (Figure 1.1.1-1), which has most of its 3,310 square meter basin in the foothills. Figure 3.2.2.1-4 is a composite hydrograph of the Kuparuk River that demonstrates the distinctive seasonal flow characteristics of streams on the North Slope (URS Corporation 2001).

Colville River

Walker and McCloy (1969) described the seasonal distribution of flow in the Colville River as follows:

- Winter is an approximately 33-week period of little flow.
- Spring is an approximately 3-week period characterized by increasing flow, break-up of the ice cover, and flooding.
- Summer is an approximately 12-week period of low flow during dry periods and higher flow during rainy periods.
- Fall is an approximately 4-week period of low, stable flow.

The USGS gaged the Colville River at Nuiqsut from June 9 to September 30, 1977. The gaging station was located just downstream of the confluence with the Itkillik River and upstream of the junction of the East and Nigliq Channels. The maximum average daily flow of 277,000 cfs was recorded on the first day. As shown by Figure 3.2.2.1-5, flow continued to decrease throughout the remainder of the summer to a low of 9,800 cfs at the end of the gaging season (USGS 2003).

The USGS recently established a continuous recording gaging station on the Colville River at Umiat (approximately 75 miles upstream from Nuiqsut) in August 2002. Although several discharge measurements have been made, the rating curve is not fully developed and discharge data are not yet available (USGS 2003). Earlier continuous stage and discharge records of the Colville have been collected from May 25 to October 20, 1962 by Arnborg, et al (1966), and for much shorter infrequent periods, generally around breakup, from 1992 to 1995 by Jorgenson, et al (1996).

Continuous water surface elevations and discharge data were also collected for the Fish Creek Basin streams in 2001. The data collection began during break-up in June and ended during the first stages of freeze-up in early September. Figures 3.2.2.1-6 through 3.2.2.1-8 demonstrate that water surface elevations and peak discharge do not correlate well during break-up, but are closely related afterwards. The figures also show that Judy and Fish Creeks both experienced increases in discharge during the latter part of the summer associated with August rainfall events. These events produced much smaller peak flows than those that occurred during break-up.

FLOODING REGIME

The mechanism that produces floods on North Slope rivers is influenced by the type of physiographic region drained, the size of the drainage area, and the frequency of the event being considered. Snowmelt flooding occurs annually in all North Slope rivers. For rivers having drainage basins entirely within the Arctic Coastal Plain, snowmelt flooding nearly always produces the annual peak discharge. The flooding regime is more complex for those basins with a significant portion of their drainage area in the Brooks Range and Arctic Foothills in addition to the Arctic Coastal Plain. Basins that drain the Brooks Range and Arctic Foothills can experience summer floods from large rainstorms. On these rivers, rainfall floods are less frequent than snowmelt floods, but could produce larger, less frequent floods. In 27 years of data on the Sagavanirktok River near Sagwon, the two largest floods resulted from rainfall.

All the observed peak flows (i.e., 15 years in total) on the Colville River have occurred during spring break-up. Summertime precipitation or late summer/fall snowmelt events have been observed to produce low magnitude floods on the delta. High-intensity, low-duration rainfall combined with a saturated active layer has resulted in rapid and relatively large volume contributions to the channels and in upstream areas. These rainfall floods, however, have been smaller than the typical floods associated with spring break-up. For example, as noted above, in 2003 the peak breakup flow in Umiat was 234,000 cfs (USGS, 2004) and at the head of the Delta 350,000 cfs (Michael Baker, 2003), compared to the peak in July of 116,000 cfs (rainfall-runoff generated) at Umiat, and later in the year a fall (October) peak of 83,900 cfs (largely snowmelt-generated) at Umiat (BLM 2004). The large rain-induced floods on the Colville River have approximated the water surface elevation and velocity of about a 2-year spring break-up (Michael Baker, Jr. Inc. 2004b).

Head of Colville River Delta

Long-term records of flow do not exist for the Colville River. However, on the basis of more than 40 years of observations made by the Helmericks family (J. Helmericks 1996, Michael Baker Jr. Inc. 2002c, 2002d), rainfall events were not observed to have produced over-bank flooding. Given the information provided by the Helmericks and considering the size of the drainage basin, it is likely that the spring snowmelt period yields the largest floods in the Colville River.

A few years of observation in the 1960s and 1970s and more frequent observations from 1992 to 2003 indicate that the peak break-up discharge for the Colville River at the head of the Delta typically occurs between mid-May and mid-June (see Table 3.2.2-3). On the basis of these data, the median date of peak break-up discharge is around May 31. Generally, the main channels are ice-free within a few days before or after the peak discharge. Although in some years ice does not clear completely from the channels for as long as 2 weeks after the peak discharge (Ray and Aldrich 1996), the timing of the peak discharges has occurred during or after the timing of the peak water surface elevations. For example, in 2002, at the head of the Colville River Delta, the peak discharge of 300,000 cfs occurred with a river stage of approximately 14 feet msl on May 27 (as discussed in Section 4A.2.2, based on an analysis of stage-discharge rating curves, some of the peak discharge estimates may be ice-effected and possibly overestimated), 3 days after the peak water surface elevation of approximately 17 feet with a discharge of 230,000 cfs (Michael Baker Jr. Inc. 2002c).

TABLE 3.2.2-3 SUMMARY OF BREAK-UP DATA OBTAINED AT THE HEAD OF THE COLVILLE RIVER DELTA, 1962–2003

Year	Approximate Date Water Began to Flow	Peak Water Surface Elevation (feet BPMSL)	Peak Break-Up Discharge[1](cfs)	Date of Peak Water Surface Elevation[2]	Number of Days Between First Water and Peak Flow
2003	May 27	13.8	350,000	June 5	9
2002	May 23	16.9	300,000	May 24	1
2001	June 5	17.4	300,000	June 10	5
2000	June 8	19.3	580,000	June 11	3
1999	May 22	14.0	203,000	May 30	8
1998	May 21	18.1	213,000	May 29	8
1997	May 20	15.1	177,000	May 29	9
1996	May 15	17.2	160,000	May 26	11
1995	May 8	15.7	233,000	May 16	8
1994	May 16	13.0	159,000	May 25	9
1993	-	20.0	379,000	May 31	-
1992	-	14.7	188,000	June 2	-
1977	-	19.9	407,000	June 7	-
1973	May 25	-	-	June 8	11
1971	May 23	-	-	June 2	10
1964	May 28	-	-	June 3	6
1962	May 19	13.2	215,000	June 14	26

Source: Michael Baker Jr. Inc. 2003

Notes:

[1] None of the peak values were measured directly; all the values were estimated indirectly by either stage-discharge extrapolations or using a simplified slope-area method.

[2] The date of the peak water surface elevations does not coincide with the timing of the peak discharge, but usually occurred up to a week before the peak discharge.

A review of the 17 available years on record show that the estimated peak break-up discharge at the head of the Delta has ranged from a low of 159,000 cfs in 1994 to as much as 580,000 cfs in 2000, and has averaged approximately 270,000 cfs. Also, a 1989 flood was estimated to have a peak break-up discharge of 775,000 cfs (this peak was estimated as the best-fit of high-water driftline elevations and a two-dimensional model of the delta discussed in section 4A.2.2; the one standard deviation of the estimate yields a discharge ranging from 665,000 to 930,000 cfs), but no water surface elevation data are available for this event. Recorded peak water surface elevations have ranged from a low of 13 feet in 1994 to 20 feet in 1993, with an average peak water surface elevation of approximately 16.5 feet. Flow velocities at the head of the Colville River Delta during the 2-year spring peak discharge are on the order of 5 to 6 feet per second (fps) (Micheal Baker Jr. Inc. and HydroConsult 2002).

Although break-up flows on the Colville River only last approximately 3 weeks, they represent approximately half the total annual flow (Micheal Baker Jr. Inc. and HydroConsult 2002). For the smaller basins originating only on the Arctic Coastal Plain, the break-up flows represent a much higher proportion of the total annual flow. In 1971 an estimated 55 percent of the annual flow of the Colville River occurred during an 18-day period of spring break-up (Walker 1972). In 1962, however, break-up flooding occurred during a 30-day period (Arnborg et al. 1967), during which 45 percent of the total flow was recorded only between the 6 days from May 24 to

May 30. Although data for other years are sparse, these two years are representative of the type of flow volumes during typical break-up flooding.

Colville River Delta

Although historical hydrologic data for the Colville River Delta are in general limited, break-up studies have been conducted on the Delta since 1992 (Michael Baker Jr. Inc. 2003). These monitoring efforts have been developed to further the understanding of the hydrologic characteristics associated with spring break-up flooding events and provide data needed for the design of production pads and other oil field facilities adjacent to the Nigliq, Sakoonang, Tamayayak and Ulamnigiaq Channels. Reports by Michael Baker Jr. Inc. (2003, 2002c, 2002d, 2001b), summarize the observations and measurements made during recent spring break-ups. Additional studies concerning break-up of the Colville River Delta and modeling of flood stages in the vicinity of CD-3 and CD-4 have also been prepared by Michael Baker Jr. Inc. (2004a, 2002a, 2002b, 2001a, 1998).

The Michael Baker Jr. Inc. studies focused on measuring the change in water surface elevations through the 1- to 2-week break-up period at representative locations in various distributary channels and near the head of the Colville River Delta. Water surface elevations were measured on an approximate daily basis from direct observations of temporary staff gages at each monitoring site, high-water marks left on the staff gages, or surveyed level loops of water levels or high-water marks. Further, peak discharges were estimated by using a simplified USGS slope-area method (Michael Baker Jr. Inc. 2001a).

During 2002, the peak water surface at the gaging station adjacent to the CD-3 production pad occurred between 1:35 p.m. on May 25 and 11:45 a.m. on May 26 at an elevation of 9.6 feet British Petroleum mean sea level (BPMSL). Measured peak water surface elevations in the immediate vicinity of CD-3 were compared to water surface elevations predicted by the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr. Inc. 2002b, 2001a, 1998, Shannon & Wilson Inc. 1996). From a linear interpolation between the water surface elevations predicted for the 2- and 10-year open-water floods, it was estimated that the peak water surface elevations observed during spring 2002 at CD-3 will likely be equaled or exceeded on average approximately once every 7 years.

Peak water surface elevations near the CD-4 production pad were monitored during the 2000 and 2001 spring break-ups. The peak water surface elevation was estimated to be between 10.5 and 11.0 feet BPMSL, and to have an average return period of approximately 20 years (based on predicted water surface elevations) during 2000. During 2001, the peak water surface elevation was estimated at 10.2 feet BPMSL and to have an average return period of 7 years (based on predicted water surface elevations) (Michael Baker Jr. Inc. 2002c).

During break-up 2002, peak water surface elevations and peak flows were estimated for three of the proposed crossings on the Sakoonang, Tamayayak and Ulamnigiaq Channels (Figure 2.4.1.1-6). The break-up data summarized in Table 3.2.2-4 indicate that discharges are greater in the Sakoonang and Tamayayak Channels.

Since 1996, peak water surface elevations have been measured and peak discharges have been estimated in various distributary channels near the Delta coastline. The peak water surface elevation at the head of the West Ulamnigiaq Channel, which is adjacent to CD-4 location, is available for 2002 and 2001. Peak water surface elevation was 5.8 feet in 2002 and 7.1 feet in 2001. Peak discharges at this location were 300,000 cfs in both 2002 and 2001. A peak discharge of 300,000 cfs corresponds to a recurrence interval of 4 years (Michael Baker Jr. Inc. 2002d). Peak water surface elevations and peak discharges for other locations along the Colville River Delta coastline are summarized in Table 3.2.2-5.

TABLE 3.2.2-4 SUMMARY OF 2002 PEAK FLOW HYDROLOGIC CONDITIONS FOR CHANNEL CROSSINGS NEAR CD-3

Channel	Estimated Time of Peak Water Surface Elevation	Peak Discharge (cfs)	Estimated Discharge at Peak Water Surface Elevation (cfs)	Width of Flow at Peak Water Surface Elevation (feet)	Maximum Depth at Peak Water Surface Elevation (feet)	Average Velocity at Peak Water Surface Elevation (fps)
Sakoonang	late evening, 26 May	10,500	9,800	450	11.6	2.7
Tamayayak	early morning, 27 May	10,700	10,700	630	12.1	2.0
Ulamnigiaq	early morning, 27 May	7,700	6,900	690	19.0	1.8

Source: Michael Baker Jr. Inc. 2002d
Note: All values are based on a 2001 cross-sections survey by Kuukpik Corporation/LCMF Inc.

TABLE 3.2.2-5 SPRING PEAK WATER SURFACE ELEVATIONS NEAR THE DELTA COASTLINE

Year	Location	Elevation (feet BPMSL)	Peak Discharge at Head of Delta (cfs)	Recurrence Interval of Peak Discharge (years)
2002	West Ulamnigiaq Channel adjacent to CD-4	5.8	300,000	≈4
	East Ulamnigiaq Channel near TBM FIOSO	5.6		
	Monument 28	3.7		
	Monument 35	5.5		
2001	West Ulamnigiaq Channel adjacent to CD-4	7.1	300,000	≈4
	East Ulamnigiaq Channel near TBM FIOSO	7.4		
	Monument 28	3.8		
2000	Monument FIORD M1	5.77	580,000	25
	TBM FIOSO	6.32		
	Helmericks House	7.39		
	Helmericks Hangar	7.24		
	N. End Helmericks Runway	7.10		
1999	Monument 28	2.85	203,000	<2
	Monument M1	3.00 ± 0.1		
1998	Monument 28	4.51 ± 0.47	213,000	≈2
	Monument 35	4.22 ± 0.08		
1997	Monument 28	3.97	173,000	<2
	Monument 35	4.73		
1996	Monument 28	4.3	160,000	<2

Sources: Michael Baker Jr. Inc. 2002d, Michael Baker Jr. Inc. and HydroConsult 2002
Notes:
Monument 28 is located approximately 2.0 miles upstream from the mouth of the Nigliq Channel.
Monument 35 is located approximately 3.0 miles upstream from the mouth of the East Channel.
Monument M1 is located approximately 2.3 miles upstream from the mouth of the Fiord Channel. TBM FIOSO is located approximately 3.5 miles upstream from the mouth channel with M1.
TBM FIOSO is located approximately 4.2 miles upstream from the mouth of the channel with M1.
The results of these recent studies indicate that fluctuations in river stage at the head of the Delta during the short break-up period have amounted to more than 9 feet. The fluctuation in stage decreased in a seaward direction to approximately 5 to 8 feet in the mid-Delta areas (near CD-4) and to less than 4 feet near the Delta mouth (near CD-3). Further, the timing of the peak discharges typically occurs after the timing of the peak water surface elevations.

Fish Creek Basin

The hydrologic conditions on Fish Creek, Judy Creek and the Ublutuoch River were investigated during 2001, 2002 and 2003 (URS Corporation 2001 and 2003, Michael Baker Jr. Inc. 2003). These water bodies were monitored to provide hydrologic and hydraulic information for engineering and environmental assessments. Noncontinuous water surface elevations and discharge data were collected during the 2001, 2002 and 2003 spring and summer seasons. Few data, however, are available to enable predictions of water surface elevations and peak water velocities caused by ice-jamming at project specific sites (bridges, roads, pads, pipes, etc.). URS Corporation (2001, 2003) established monitoring sites at six locations along Fish Creek (River miles (RMs) 0.7, 11.7, 18.4, 25.1, 32.4, and 43.3), four locations along Judy Creek (RMs 7, 13.8, 21.8, and 31.0), and two locations along the Ublutuoch River (RMs 13.5 and 13.7) during spring break-up (Figure 3.2.2.1-1). The monitoring consisted of recording snow and ice conditions and water surface elevations. During this time, discharge measurements were made periodically at various stations along each stream. During the summer, monitoring of the water surface elevations and discharge continued for each creek at four of the stations. Data for these stations are summarized in Table 3.2.2-6.

Channel cross-sectional data were collected to understand the effect of ice and snow on water surface elevations, the magnitude and timing of flood peak, and the magnitude of the observed riverbed movement. For example, at Fish Creek RM 25.1, peak water surface elevation was affected by ice in 2001 but not 2002. Although peak discharge was higher in 2002 than 2001, peak stage was higher in 2001 than 2002 because of the ice affect. At Judy Creek RM 7.0, peak water surface elevation was affected by ice in 2001 but not 2002. Similar to Fish Creek, peak discharge was higher in 2002 than 2001 but peak stage was higher in 2001 than 2002 because of the ice affect. Spring break-up occurred earlier in the Ublutuoch River than in Fish or Judy Creeks. At the Ublutuoch River RM 13.7, ice was in the channel at the time of peak stage in 2002. Although peak discharge was higher in 2001 than 2002, peak stage was higher in 2002 than 2001 because of the ice affect. (URS Corporation 2003).

Michael Baker Jr. Inc. (2003) conducted quantitative and qualitative evaluations of 2003 spring break-up of Fish Creek, Judy Creek and the Ublutuoch River. Water surface elevation monitoring stations were set up at RMs 32.4, 25.1, and 11.7 in Fish Creek; RMs 13.8 and 7.0 in Judy Creek; and RMs 1.9 and 6.8 in the Ublutuoch River. RM 6.8 of the Ublutuoch River is the site of a proposed bridge under Alternative A—CPAI Development Plan. Water surface elevations were recorded throughout spring break-up. Peak stage occurred between June 5 and June 8 at the three monitoring stations in Fish Creek. The channel was free of ice at the upstream station at the time of peak stage. Floating ice was in the channel at the middle station during peak stage, which affected the observed water surface elevation. At the downstream station, ice may have been in the channel during peak stage. Thus, it is unknown if the observed water surface elevation was affected by ice.

In Judy Creek, peak stage occurred either late on June 5 or early on June 6. Bottomfast ice was not present in the channel during peak stage; indicating peak water surface elevations were not ice-affected. In the Ublutuoch River, peak stage occurred either late on June 6 or early on June 7 at the upstream station. Peak stage at the downstream station of the Ublutuoch River coincided with that of Fish Creek at the downstream station. It is likely that the flooding conditions on lower Fish Creek produced backwater effects on the lower Ublutuoch River that affected the timing and elevation of the peak water surface at Ublutuoch RM 1.9. Bottomfast ice was in place at both monitoring stations during the peak stage. Thus, observed water surface elevations were affected by ice, which is an important consideration for bridge design.

In the Ublutuoch River, discharge was directly measured near the proposed bridge site at RM 6.8 on June 9 and 10. Discharge was indirectly measured using channel slope, channel cross-section, channel ice depth and water surface elevation for the period of spring break-up. Observations made from flight reconnaissance during the break-up period noted that the lower west floodplain was fully inundated and conveyed flow during high flows and/or during periods when ice was in the main channel. The east and upper west floodplains were also inundated during spring break-up but conveyed little flow.

Recently, a small streams monitoring project was implemented to make observations and collect data during breakup on seven small unnamed tributary streams within the Fish Creek Basin (PN&D, 2003. The basins for these streams are all less than 10 square miles but will be crossed byt the proposed roads to CD-5, 6 and 7. Three of the streams are well-developed beaded streams, while the others range from 1 to 2 ft wide channels to broad swales that concentrate overland flow.

FLOOD FREQUENCY PREDICTIONS

Peak discharge data collected at the head of the Colville River Delta and data from two nearby rivers (Kuparuk and Sagavanirktok Rivers) were used to estimate the flood magnitude and frequency of the Colville River (Shannon & Wilson 1996, Michael Baker Jr. Inc. and HydroConsult 2002). The flood-peak discharge estimates for head of the Colville River are presented in Table 3.2.2-7. This study and the uncertainty associated with the flood frequency predictions is discussed in detail in Sections 4A.2.2.6 and 4F.2.2.6.

Also, Michael Baker Jr. Inc. (2004, 2002d, 1998), and Shannon & Wilson Inc. (1997) predicted water surface elevations based on similar analyses for the Colville River Delta, including at the existing Alpine Development Project facilities, at the pad locations and at the proposed and existing bridge crossings. Modeling and analyses indicate that, at the time of the peak discharge of the 50-year flood, most of the Delta will be under water (Michael Baker Jr. Inc. 2004a). Observations of flooding on the Delta indicate that floodwaters often cover up to an estimated 65 percent of the Delta (Walker 1983). In 1992 (less than a 2-year flood event) and 1993 (approximately a 5-year flood event), floodwaters covered an estimated 43 percent and 58 percent, respectively, of selected portions of the Delta (Jorgenson et al. 1994).

Similarly, other than the data collected in 2001 and 2002 (URS Corporation 2001, 2003), no other historical flood-peak discharge data are available for Fish Creek, Judy Creek, nor the Ublutuoch River. Flood frequency and magnitude were estimated for various locations along these streams by using historical data collected on other rivers in the region and the 2001 and 2002 data recently collected. URS Corporation (2003) estimated flood frequency discharges by assuming that the average flood-peak discharges observed in 2001 and 2002 were equal to the mean annual flood (the 2-year event), and by adjusting the regional flood frequency curve to reflect this relationship. The flood-peak discharge estimates for the Fish Creek basin streams are presented in Table 3.2.2-7.

URS Corporation (2003) utilized historical and 2001 through 2002 discharge data, water surface elevation data, and hydraulic roughness to estimate a water surface profile for the 100-year flood period along Judy Creek and Fish Creek. The models used in this analysis assume that the channels are unaffected by snow and ice blockages. Figure 3.2.2.1-7 shows the area inundated by a 100-year event (URS Corporation 2003). The floodplain is widest at the mouth of Fish Creek (6 miles). The width of the floodplain at Fish Creek RM 25.1 is 2 miles.

On the basis of the flood frequency analyses performed by URS Corporation (2001, 2003) for the Fish Creek basin streams, the annual peak discharge associated with snowmelt events, for a given return period, is greater than the annual peak discharge associated with rainfall events. Similarly, for a given magnitude of annual peak discharge, it is more likely that the flood-peak will occur as the result of snowmelt rather than rainfall.

It should be noted that for both the Colville River Channels and the Fish Creek basin streams, the peak flows usually occur after the peak water surface elevations. The current two-dimensional model used to estimate peak flow during break-up in the Colville River Delta does not account for channel ice or ice jams. The one-dimensional model and normal depth computations used to estimate peak flow during break-up in Fish Creek streams allow channel ice but not ice jams to be modeled. Although data used in the models was obtained when channel ice was present, the models do not account for channel ice and/or ice jams. During a low frequency event, such as a 200-year event, most of the Delta is submerged. An ice jam or channel ice in one channel will have very little overall effect on delta-wide water surface elevations.

Both channel ice and ice jams have the potential to significantly alter local water surface elevations, but the lack of a model that predicts the effects from channel ice or ice jams on the delta does not affect pad and road design. Pad and road height are governed by thermal criteria, not by flood criteria. For example, the water surface elevation for a 200-year event at CD-4 is 15.7 ± 1 feet. The pad height was designed to be 19.0 feet.

STORM SURGES ON THE FRINGE OF THE COLVILLE RIVER DELTA

A storm surge is coastal flooding caused by the seawater piling up against the shore as a result of wind stress and atmospheric pressure differences caused by a storm. Along the northern coast of Alaska, storm surges usually occur during late summer and fall (August to October). The two worst cases of surge flooding on record occurred in October 1963 and September 1970 (Reimnitz and Maurer 1979, Lynch et al. 2002). Along the fringe of the Colville River Delta, two storm surge drift lines (identified by local residents as related to the 1963 and 1970 storms) had elevations of 5.0 and 6.6 feet above msl, respectively (Jorgenson et al. 1993). Estimates of storm surge heights at the Delta fringe for frequency intervals of 10, 50, and 100 years are 6.5, 9.2, and 10.6 feet, respectively (Jorgenson et al. 1993).

Gloersen et al. (1999), Lynch et al. (2004) and Walsh et al. (1996) comment on the change in intensity, frequency and impact of high-wind events as a function of climate change. The storm surges in 1963 and 1970 were caused by Beaufort-Chukchi cyclones, one type of high-wind event. The intensity of Beaufort-Chukchi cyclones has significantly increased over the past 40 years in summer but not in other seasons (Gloersen et al. 1999, Lynch et al. 2002). While cyclone frequency throughout the arctic is highly variable over long time scales, the frequency of cyclones in the Beaufort-Chukchi region has been historically low. The intensity and frequency of cyclonic activity throughout the arctic is associated with the amount of open-water and sea ice. Such a correlation has not been found for the Beaufort Sea. Open-water in the Beaufort Sea has little or no influence on subsequent local surface winds or sea level pressure distribution. Accordingly, retreating sea cannot be considered to be a strong influence on the past or future trends in the frequency or intensity of Beaufort-Chukchi cyclones (Lynch et al. 2003). However, retreating sea ice will have implications for the impacts of storms on the northern coast of Alaska (Office of Naval Research, Arctic Research Commission (2004). Sea ice protects the coast from storm surges. As sea ice retreats, the impact of storm surges will increase. Climate change increases the probability of storm surge events.

Of particular concern and difficult to forecast is the potential effect of storm surges during a large summer storm and the effect, if any, that a simultaneous storm surge during any large flows would have on river stage and discharge because of a sea level rise at the river mouth. Frequency analyses of observed storm surges and hindcast analyses of the strongest westerly storms suggest 6 feet as the 100-year storm surge. This estimate is based on surges resulting from storms that occurred only during August through October. These late summer/fall storm surges could affect the lower portions of the Delta (i.e., in the vicinity of CD-3), but this is a time when streams are at their lowest point and thus it will likely not be an issue. There are no recorded observations of strong westerly storms during the months of May and June, when the spring break-up occurs and stream flow is highest (URS Corporation 2001), but usually at this time, the sea ice is shorefast and storm surges are not an issue.

COLVILLE RIVER SEDIMENT EROSION, TRANSPORT AND DEPOSITIONAL PROCESSES

Very little information is available regarding sediment transfer processes in the Colville River. Arnborg, et al. (1967) found that about 5.8 million tons of silt was transported down the Colville River during the hydrologic year of 1962, and about three-fourths of this total was transported during a 20-day period centered around spring break-up. The 1962 flood is considered to be equivalent to the mean annual, or approximately 2-year flood (Michael Baker, Jr. Inc. 2004b). Sediment loads during summer floods are more dependent on stage and can be relatively high because sediment sources are unfrozen and highly mobile. The highest summer suspended sediment concentration noted in the 1962 study, nevertheless, was less than half that measured during the spring break-up period (Michael Baker, Jr. Inc. 2004b).

The bulk of sediment movement and thus deposition in the lower Delta is assumed to be associated with spring break-up. High velocity springtime events flush out accumulated sediment and maintain channel depths in major channels like the Nigliq. Sedimentation during spring break-up events usually occurs in over-bank areas. It is probable that without the high springtime velocities, many of the subordinate channels in the lower Delta would fill with silt (Michael Baker, Jr. Inc. 2004b).

High break-up flood velocities keep the majority of sediment from settling out before reaching the coast. When sea ice is still intact during break-up, highly-sediment-charged floodwaters tends to flow out over the sea ice and then deposit the load on the sea ice. A portion of this sediment is deposited on the ocean’s floor at the foot of the Delta, the remainder, still riding on the ice pack, is carried out to sea as summer coastal currents move the ice away from the shore. Michael Baker, Jr. Inc. (2004b) estimated that over 580,000 cy of silt is delivered to the ocean by the Nigliq Channel during a typical 20-day period centered around break-up.

Rain-induced floods, however, can combine relatively high sediment loads with lower relative velocities. These events could result in significant amounts of deposition within low relief areas such as subordinate channel mouths. Rain-induced events can thus be a significant contributor of sediment to the downstream portion and the mouth of channels like the Nigliq (Michael Baker, Jr. Inc. 2004b).

DELTA-WIDE BANK AND CHANNEL MIGRATION

Based on observations and measurements of bank migration within the Colville River Delta, Walker (1994) concluded that the majority of annual bank erosion within the delta occurs within a two- or three-week period during or shortly after the spring break-up flood. He found that the maximum bank erosion often occurred during the recession of the break-up flood peak. During summer when thawed banks are more susceptible rain-induced flood events also account for erosion. According to Michael Baker, Jr. Inc. (2004b), bank erosion within the Delta typically proceeds in abrupt steps, separated by long periods of apparent stability.

COLVILLE RIVER DELTA COASTAL PROCESSES

Although the Delta is primarily shaped by fluvial processes, its coastline is shaped by nearshore ocean currents and wind. The predominant longshore or littoral currents at the Delta mouth parallel the shore and trend strongly from east to west. Michael Baker, Jr. Inc. (2004b) reported that about 80 percent of the spring break-up sediment load is delivered to the ocean via the East Channel, however, the portion of this sediment that is entrained and moved in a westerly direction by littoral drift is unknown. It is likely that a sizable portion of the sediment that eventually ends up at the mouth of the Nigliq Channel originally came from the East Channel but was subsequently re-entrained by the sideshore currents and transported in a westerly direction.

Additionally, Michael Baker, Jr. Inc. (2004b) also noted that the Arctic coastline is becoming more active and that apparently, shore to ice distances in the Arctic Ocean as a whole have increased over the last several decades. Because pack ice retreat increases fetch, increased waves and energy impact the coast. A more active and more mobile coast results. The increased sediment transport from the East Channel toward the mouth of the Nigliq Channel via littoral drift may be one result of a more mobile coastline.

TABLE 3.2.2-6 SUMMARY OF DISCHARGE AND WATER SURFACE ELEVATION DATA FOR FISH CREEK BASIN STREAMS

	Fish Creek at RM 25.1			Fish Creek at RM 32.4			Judy Creek at RM 7.0			Ublutuoch River at RM 13.7		
Date	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (ft BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**
2001												
6/7	17.56	3110	1.48									
6/8	18.33	4760	1.88	20.78	709	0.76	26.72	3957	NA			
6/9	18.08	5185	NA	20.87	698	0.75	26.31	4410	2.90			
6/10										17.07	1440	3.82
6/11	16.97	6050	2.93	21.67	2070	1.81	25.36	3826	NA			
6/12										15.10	1170	3.84
6/13	16.14	4600	2.71							13.07	988	3.77
6/14				21.56	3100	2.29						
6/15	16.99	6100	2.95	22.23	3657	NA	24.44	2300	2.87			
6/16				21.60	3120	2.25						
7/17	10.91	755	NA	17.43	578	1.78	20.30	154	0.47			
7/18										5.72	35.6	1.14
8/13										5.74	33.9	1.12
8/14	10.18	511	NA	16.92	345	1.54	20.25	157	0.46			
9/5	10.25	511	NA	16.95	349	1.29	20.15	158	0.52			
9/6										5.85	41.7	1.31

TABLE 3.2.2-6 SUMMARY OF DISCHARGE AND WATER SURFACE ELEVATION DATA FOR FISH CREEK BASIN STREAMS (CONT'D)

	Fish Creek at RM 25.1			Fish Creek at RM 32.4			Judy Creek at RM 7.0			Ublutuoch River at RM 13.7		
Date	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (feet BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**	**Water Surface Elevation (ft BPMSL)**	**Discharge (cfs)**	**Average Velocity (fps)**
2002												
5/22										18.06	1903	3.21
5/23	16.74	6752	3.28	20.60	1584	1.48	25.60	5053	NA	16.32	1711	3.47
5/24	17.70	8575	3.67	21.15	1800	NA	26.34	6823	4.92	14.87	1416	3.44
5/25	18.22	8910	3.83	21.76	2334	1.68	26.76	7125	4.81			
5/26	18.08	8930	3.75									
5/27				22.42	3703	2.27						
5/28	16.95	4760	2.54	22.00	3110	2.14	25.05	1531	NA			
5/31	16.00	4018	2.29									

TABLE 3.2.2-7 FLOOD PEAK DISCHARGE ESTIMATES FOR STREAMS IN THE PLAN AREA

Location	Drainage Area (mi^2)	Discharge (cfs)				
		2-year	10-year	50-year	100-year	500-year
Colville River (Head of Delta)	20,920	240,000	470,000	730,000	860,000	1,300,000
Fish Creek at RM 0.7	1,827	17,500	32,100	46,700	53,000	72,000
Fish Creek at RM 25.1	1,461	14,100	26,100	38,300	43,600	59,800
Fish Creek at RM 32.4	783	7,700	14,700	22,100	25,400	35,900
Judy Creek at RM 7.0	647	6,400	12,300	18,600	21,500	30,500
Judy Creek at RM 13.8	593	5,800	11,400	17,300	19,900	28,400
Ublutuoch River at RM 8.0	233	2,400	4,800	7,600	8,900	13,100
Ublutuoch River at RM 13.7	222	2,200	4,600	7,200	8,500	12,600

Sources: Michael Baker Jr. Inc. 2002c and URS Corporation 2003
Note: The error estimate of discharge is ±10%.

CHANNEL BED AND STREAM BANK STABILITY FOR FISH CREEK BASIN STREAMS

Observations of bed conditions on the Fish Creek basin streams suggest that bed load transport can be significant and the bed channel forms might not be stable under normal high-flow conditions. URS Corporation (2001, 2003) recently conducted studies of bed load transport and the stability of the beds of the Fish Creek basin streams. Bed load was measured twice during 2002 break-up season only on Fish Creek (RM 25.1). It was estimated that 351 and 423 tons per day (tpd) were transported on May 25 and May 26, 2002, respectively, during a flow of approximately 8,900 cfs (the approximate peak flow of 2002).

During break-up 2001, URS Corporation collected samples of the bed material on Fish Creek, Judy Creek, and the Ublutuoch River. These data are summarized in Table 3.2.2-8. In general, the bed material in Fish and Judy Creeks is more fine-grained and more mobile than in the Ublutuoch River. As an example, the unstable bed conditions of two gaging station locations along Fish Creek (at RMs 25.1 and 32.4) are shown by Figures 3.2.2.1-10 and 3.2.2.1-11. The figures indicate that while the channel width remained the same, during break-up between June 8 and June 14, 2001, the Fish Creek bed was scoured up to 7 feet in certain sections of the channel and it aggraded up to 2 feet in other sections. In contrast, very little bed change was measured on the Ublutuoch River at RM 13.7. In fact, during the time of the peak water surface elevation and peak discharge on the Ublutuoch River, the water was flowing on snow and bottomfast ice within the channel.

TABLE 3.2.2-8 BED MATERIAL ON FISH CREEK, JUDY CREEK, AND THE UBLUTUOCH RIVER

Stream Course	River Mile	Bed Material	D50[1] (feet)	Riverbed Elevation Change During Break-Up (feet)	
				2001	2002
Fish Creek	25.1 32.4	sand with some silt	0.00041 0.00012	5 to 7	1 to 3
Judy Creek	7.0	sand with some silt	0.00057	5	2
Ublutuoch River	13.7	gravel with some sand	0.02300	not mobile	not mobile

Source: URS Corporation 2003
Notes: [1]D50 is the median grain size of the bed material.

ICE CONDITIONS

FREEZE-UP AND WINTER CONDITIONS ON RIVERS, THE COLVILLE RIVER DELTA, AND HARRISON BAY

From November through May or June, 90 to 100 percent of the Beaufort Sea is covered with sea ice (MMS 1996). The formation of sea ice may start as early as September or as late as December. During the first part of freeze-up, near-shore ice is susceptible to movement and deformation by modest winds and currents. Movement could be a mile or more per day, and deformation could take the form of ice pile-ups and ride-ups on beaches and the formation of offshore rubble fields and small ridges. Ice ride-ups occur when a whole ice sheet slides in a relatively unbroken manner over the ground. Ride-ups larger than 160 feet are not very frequent. By late winter, first-year sea ice is approximately 6 to 7 feet-thick. In waters 6 to 7 feet-thick, the ice is frozen to the seafloor and forms the bottom-fast-ice subzone of the land-fast-ice zone. The land-fast-ice zone could extend from the shore out to depths of 45 to 60 feet. The ice, in water depths greater than approximately 6 to –7 feet, is floating and forms the floating fast-ice subzone (consisting of floating ice unattached to land). As the winter progresses, extensive deformation within the land-fast-ice zone generally decreases as the ice thickens and strengthens and becomes more resistant to deformation (BLM and MMR 1998a).

Seaward of the land-fast-ice zone is the stamuhki, or shear, zone. This zone is a region of dynamic interaction between the relatively stable ice of the land-fast-ice zone and the mobile arctic pack ice. This interaction results from the formation of ridges and leads—or areas of open-water. The plowing action of drifting ice masses could cut linear depressions, or ice gouges, into the seafloor sediments. The dominant orientation of these gouges generally is parallel to the coast. In the Beaufort Sea, the region of most intense ridging and gouging occurs in water depths of approximately 50 to 100 feet. In water depths of less than 30 feet, the maximum gouge depths generally are less than 1 foot (Weeks et al. 1984). Ridges with keels deep enough to become grounded help to stabilize the land-fast ice.

BREAK-UP ON HARRISON BAY AND THE BEAUFORT SEA

Along the Beaufort Sea coast, break-up generally begins approximately mid-July but could occur in mid-June or late August (MMS 1996). River ice begins to melt before sea ice and, during the early stages of break-up, water from rivers could temporarily flood ice that has formed on deltas. The floodwater will drain through openings in the ice, and the force of the water could be great enough to scour depressions on the seafloor—these depressions are called strudel scours. As break-up proceeds, there is an increase in open-water areas as the ice moves farther offshore. During the summer and fall, shifting winds and currents can move the pack ice toward or away from the coast. In some years, the pack ice could remain along or very near the coast. Movement of the pack ice along the coast could cause some individual pieces to become grounded in shallow waters, where they could remain for the summer.

IMPACT OF ICE ON FLOODING DURING BREAK-UP

Colville River Delta

Ice jams in the Colville River and Delta channels have been observed to cause significant flooding on the Delta during spring breakup periods of low to moderate discharge (Walker, 1983; Michael Baker, 2004d). Ice jams form during the early spring period of thaw and are composed of fragmented ice formed by the breakup of an upstream ice sheet. The ice cover is broken during a rapid rise in river discharge associated with snowmelt runoff that accompanies increased air temperatures, solar radiation and sometimes rain on snow events (USCOE, 2002). An ice jam is a stationary accumulation of ice that restricts flow in a river. The flow restriction may cause significant increases in water levels upstream of the jam, and significant decreases in flow and water levels downstream of the jam (White and Zufelt, 1974). Two kinds of ice jams can form along a river reach: the simple ice jam and the dry ice jam (Michel, 1971). The simple ice jam is common on the Delta and occurs when ice floes accumulate in front of a solid ice cover. Typically, the ice jam is of uniform shape and water flows freely (but under pressure) under the accumulated ice. Due to the jam's characteristic static manner, it produces a regular increase in water level along its length. The jam is destroyed when the rate of increase of river discharge exceeds a particular threshold or by the impact of further oncoming ice floes.

The dry ice jam, less commonly observed on the Delta but still an imporant condition, is formed by the jamming of ice floes at an obstacle which may be an existing ice accumulation or irregularity in river channel width, depth, slope and/or curvature. In this case, the ice jam completely blocks the whole flow section down to the river bottom. The water has to flow by infiltration through the ice plug which results in rapid upstream increases in water level. The jam is unstable and moves out when the upstream water level increases above a threshold (Michel, 1971).

The main factors affecting ice jam formation are the previous winter conditions, the shape and size of the breakup discharge and relative positions of fluvial transitions and hydraulic features (Michel, 1971). Ice jams are typically characterized by broken, fragmented ice pieces that begin at a river channel location where the volume of ice transported to the location exceeds the ice transport capacity. Once the ice pieces reach a jam initiation point, the ice fragments cease moving, begin accumulating and form an ice jam. The maximum size of an ice jam depends on flow conditions, available ice supply, the strength and size of ice pieces (USCOE, 2002) and the hydraulic geometries of the ice jam location (Michel, 1971).

The maximum extent of the effects of ice jams is largely controlled by the physiography of the river channel, floodplain and valley. Ice jams that form in relatively moderate to steep gradient rivers confined by valleys can result in large water-level rises that flood the immediate areas. Some of these can be severe; for example, the Yukon river rose 65 ft in the spring of 1930 to flood the village of Ruby (Henry, 1965). Water level rises of 20 ft or more are common when an ice jam is formed. In contrast, ice jams that form in relatively gentle unconfined terrain, like the Colville River Delta, can result in restricted (governed by Delta relief and channel geometry as opposed to the height of valley walls) water-level rises but with widespread inundation.

In 1966, although no measurements of discharge or water surface elevations were recorded at the time, an ice jam in the vicinity of the Putu Channel (near the present location of Nuiqsut) caused water to flow over the bank for up to 4 miles east of the East Channel. Also at this time, ice floes were deposited up to 1 mile east of the East Channel (PAI 2002).

Observations of ice jams on the Colville River indicate that they are composed of large chunks and flows to small pieces. Ice jams with larger pieces tend to be more common during the early stages of breakup. Less often a jam is composed of a single large floe, but when they do occur can cause signficant changes . During spring breakup 2004, a large single floe (over 5,000 ft long by 1,250 ft wide) was wedged diagonally across the entrance to the East Channel of the Delta, extending across the entire width of the channel under water. The ice-jam blockage caused a higher than normal proportion of water to flow into the Nigliq Channel (Michael Baker, 2004d). During breakup 1981, a very large floe was carried from the main channel near the Itkillik River just upstream of the head of the Delta into the entrance to the Nigliq Channel. The wedged floe was anchored to the right bank on peat and to the left bank on sand dunes. The ice jam was sufficient to divert most of the Nigliq Channel water back to the east through the Putu Channel and back into the main East Channel (Walker, 1982).

In support of oilfield development activities, systematic and continuous qualitative monitoring of ice conditions and ice jams on the Delta during spring breakup began in 1998 (Michael Baker, 2004d). The ice monitoring programs have included aerial and ground-based observations and photography. Daily aerial surveys have become a principal component of the programs. The daily surveys are begun as soon as floodwaters are present and continue until all floating ice has moved out of the channel. Daily observations of the status of ice in the various major channels, the locations of ice jams and the presence or lack of ice-related flow alterations (i.e., overbank flooding or backwater effects) are recorded. When taken in summary over the past seven years, the surveys provide very useful information regarding typical ice behavior and ice jamming trends (i.e., frequency at a location, typical area of effect) on the Delta.

Based on data and information from ice monitoring studies conducted in 1981 (Walker, 1982), 1993 (Shannon & Wilson, 1993) and the 1998-2004 ice survey programs described above, Michael Baker (2004d) prepared a table summarizing the locations of ice jam observations including a provisional frequency of occurrence rating (Table 3.2.2-9) and a map depicting ice-jam prone locations on the Colville Delta (Figure 3.2.2.1-12). They caution that only generalized conclusions should be made due to: 1) the limited data base, 2) ice surveys were not identical from year to year (i.e., due to variations in weather, flight patterns, program interests, and the steady improvement of ice survey techniques), and 3) the subjective (qualitative) nature of the surveys. Further, much of the available data does not support differentiating between minor or major jams or the effects of these jams. Nevertheless, the data and information in Table 3.2.2-9 and Figure 3.2.2.1-12 provide a useful framework to identify potential ice jam locations and to help address possible impacts associated with ice jamming. The table and figure indicate that over the period 1998-2004, when there were at least seven years of observations, ice jams were observed at least four of those years at five locations:

- just upstream of the head of the Delta at the mouth of the Itkillik River,
- at the meander bend in the Nigliq Channel just upstream of Nuiqsut,
- in the Putu Channel,
- at the entrance to the Sakoonang Channel, and
- in the Sakoonang Channel between the entrance and the Alpine facilities.

Two other locations also appear prone to ice jams (3 of 7 years): the entrance to the East Channel and the Nigliq Channel at the CD-4 location.

Fish Creek Basin Streams

In Fish and Judy Creeks, observations made during the 2001 spring break-up indicate that snow and ice influence the shape and size of the channel cross-section, cause ice jams, and affect hydraulic roughness. As a result, discharge at the outset of spring break-up can result in higher water surface elevations than similar discharges later in the summer. Likewise, backwater elevations are usually greatest when water first begins to flow over snow (at the outset of spring break-up) and decrease with time and increased discharge. For example, in Fish Creek at RM 25.1 on June 7, 2001, the water surface elevation was approximately 3.7 feet higher than it would have been at a similar discharge during the summer. On June 8, 9 and 10, the differences were approximately 2.1, 1.9, and 0.8 feet, respectively. By June 11, the observed water surface elevation was equal to that which would be expected during a similar discharge later in the summer. Similar observations were made at other Fish Creek and Judy Creek locations (URS Corporation 2001).

In general, for Fish and Judy Creeks peak discharge usually lags peak water surface elevation by 1 to 3 days during break-up. While it is not uncommon for water surface elevations to drop as discharges increase during break-up, water surface elevations will increase without a corresponding increase in discharge during ice jams. It is also noteworthy that channel snow and ice affect peak water surface elevation more frequently than peak discharge. In general, channel snow and ice do not affect channel discharge unless there is a damming effect. The key point is that the peak discharge usually follows the peak water surface elevation rather than being coincident.

TABLE 3.2.2-9 ICE JAM LOCATION SUMMARY, COLVILLE RIVER DELTA 1981, 1993, 1998-2004

Observation Location	1981	1993	1998	1999	2000	2001	2002	2003	2004	Total	%
Upper Colville River											
Ocean Point	n	n						x	x	2	29%
Mouth of Itkillik River	n	n			x		x	x	x	4	57%
Monument 1	n	n	x							1	12%
Entrance to East Channel	n	n	x			x			x	3	43%
Entrance to Nigliq Channel	x	n								1	14%
Nigliq Channel											
Meander Bend just upstream of Nuiqsut	n	x		x	x	x	x	x	x	7	88%
Nigliq Slough	n	n			x		x			2	29%
At approximate location of CD-4	n	n				x	x	x		3	43%
In vicinity of proposed bridge crossing	n	n			x					1	14%
Channel reach downstream of proposed bridge	n	n								0	0%
East Channel											
Putu Channel	n	n		x	x	x	x	x		5	71%
At Colville-Kachemach confluence	n	x								1	13%
At Helmericks – Colville Village	n	n					x	n	n	1	20%
Sakoonang Channel											
Entrance to Sakoonang Channel	n	n	x	x		x			x	4	57%
Between entrance and Alpine	n	n		x	x	x	x			4	57%
Channel reach downstream of Alpine	n	n								0	0%
Tamayayak/Ulamnigiaq Channels											
Entrance to Tamayayak Channel	n	n	n	n	x	x		n	n	2	67%
In Tamayayak Channel	n	n	n	n		x		n	n	1	33%
In West Ulamnnigiaq at proposed CD-3 location	n	n	n	n				n	n		0%
In West Ulamnnigiaq downstream of proposed CD-3 location	n	n	n	n				n	n		0%

Source: Michael Baker, 2004d

Notes: % = the percentages shown represent the proportion of times ice jams were observed relative to the toal observations for each observation location.

For the Ublutuoch River, snow and ice conditions were much different than for Fish and Judy Creeks at the beginning of the 2001 break-up. The Ublutuoch River Channel was entirely blocked by snow and ice at RM 13.7. From the start of flow until June 21, the water gradually cut through the snow and ice until it reached the permanent channel bed. During this time, the snow and ice had a dramatic impact on the channel hydraulics. The shape, size, and elevation of the channel cross-section, the hydraulic roughness, and the energy slope were all affected by the snow and ice. The most significant effect was the change in the elevation of the riverbed. During the period that snow and ice affected the water surface elevation, the riverbed was physically higher than it was during the summer. The peak water surface elevation and discharge occurred sometime between June 9 and 10. At that time, flow was being conveyed on snow, approximately 8.4 feet above the permanent riverbed. As a result, the peak water surface elevation was dramatically higher than it would have been if the same discharge would have occurred during summer (URS Corporation 2001).

3.2.2.2 Surface Water Quality

No marine or fresh water in the Plan Area is impaired by pollutants, according to the ADEC. Therefore, no actual or imminent persistent exceedances of water quality criteria or adverse impacts to designated uses, as defined in the state’s water quality standards, has been documented. Water chemistry in lakes and ponds in the Plan Area is highly variable and dependent on the distance from the Beaufort Sea, frequency of flooding, and whether the lakes and ponds are tapped (connected to river channels most of the year) or perched (isolated from rivers channels most of the year) (CPAI 2002). Most freshwater bodies in the Plan Area are soft, dilute calcium-bicarbonate waters. Near the coast, however, sodium chloride (salt) concentrations are more common than bicarbonate concentrations (BLM 1998). Water bodies close to the Beaufort Sea are saline from storm surges and sea spray. As storm surges push seawater up the Colville River channels, fresh water in tapped lakes mixes with saltwater. Average salinity measurements are typically highest in river channels [12.5 part per thousand (ppt)], intermediate in tapped lakes (7.2 ppt), and lowest in perched lakes (1.0 ppt) (Moulton 1993b). The differences in salinity correspond with varying concentrations of dissolved minerals.

Winter freeze and summer recharge cycles cause contrasting effects in water quality. In winter, surface waters less than 6 feet deep on the North Slope generally freeze solid, but water bodies as shallow as 5 feet deep in the Colville River Delta may remain partially unfrozen. During winter freezing, major ions (i.e., calcium, magnesium, sodium, potassium, hardness, alkalinity, chloride, sulfate and nitrate) and other impurities are excluded from downward-freezing ice and forced into the underlying sediment. Spring snowmelt and resulting water flow across the surface of the ice removes the cover from lakes, allowing the wind to mix the water column throughout the summer. Recharge of lakes through sheet flow during spring counteracts the effects of water loss and ion concentration caused by evaporation in the summer. The net result of the input of snowmelt waters and spring sheet flow in deeper lakes is to preserve their existing water chemistry.

TURBIDITY

Turbidity, or a measure of water clarity, varies seasonally in the Plan Area with the transport of sediment by the Colville River during flooding. Most fresh waters have low suspended-solid concentrations and, therefore, low turbidity for the majority of the year. Later in summer, suspended-sediment concentrations in the Colville River decrease to as low as 3 ppm (BLM 1998). During spring break-up, the Colville River carries suspended sediment from the foothills of the Brooks Range, and has a higher turbidity than any of the smaller rivers originating within the Arctic Coastal Plain. Most of the annual sediment load is carried between May and October, with approximately 75 percent flowing to the Delta in early summer (May and June) from the beginning of break-up to the end of break-up flooding (ARCO Alaska Inc. 1997). Extrapolation of 1977 water quality sample results for suspended solids shows that sediment transport ranged from 438,000 tpd in June, to a few hundred tpd during the low-flow period in July (USGS 2003).

ALKALINITY AND PH

Alkalinity and pH are important parameters in controlling the susceptibility of fresh waters to acid rain or acid snowmelt. Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the atmosphere, which come from electric power generation that relies on burning fossil fuels like coal, are the primary causes of acid rain. The strength of the effects of acid rain depend on many factors, including how acidic the water is, and the chemistry and buffering capacity of the soils involved. Alkalinity is a measure of the acid-buffering capacity of the water. The pH is a measure of how acid the water is. A pH of 7 indicates a neutral balance of acid and base; a pH below 7 indicates acid water. The State of Alaska considers a pH range within 6.5 to 8.5 necessary to protect aquatic wildlife (ADEC 2002).

Fresh waters in Alaskan coastal tundra are only weakly buffered (BLM 1998). In ponds, alkalinities during snowmelt are about twofold lower than the midsummer alkalinities of 20 milligrams per liter (mg/L) as lcalcium carbonate ($CaCO_3$). Lake alkalinities also are low, on the order of 25 mg/L as $CaCO_3$. Alkalinities in individual coastal rivers of the Colville River Delta are higher, ranging between lows of 15 to 20 and highs of 65 to 80 mg/L as $CaCO_3$ in summer and reaching even greater alkalinity values at lower flow rates. Winter alkalinities in unfrozen pools are on the order of 150 to 200 mg/L as $CaCO_3$.

In ponds, pHs are depressed to below pH 7 as snowmelt runoff enters them. The pond pHs then rapidly increase to between 7 and 7.5 after snowmelt (Prentki et al. 1980). The initial low pH is due to acidity of snow on the North Slope, which has a median pH of 4.9 (Sloan 1987). This low pH, which is below the pH 5.5 expected for uncontaminated precipitation, is thought to be a result of sulfate fallout from arctic air masses industrially contaminated from pollution sources in Eurasia (BLM 1998). In lakes, pHs are near neutral, about pH 7 (O'Brien et al. 1995). In tundra brown-water streams (so called because of the color caused by tannins) and some foothill streams, pHs can be lower because of the presence of naturally occurring organic acids. In tundra lakes, creeks, and rivers of the Colville River system, pHs are higher, seasonally ranging between 6.5 and 8.5 (Kogl 1971).

OXYGEN

The measurement of dissolved oxygen refers to the amount of gaseous oxygen dissolved in the water. Two measurements are typically provided for dissolved oxygen levels: the absolute concentration in mg/L [or parts per million (ppm)] and the percent of saturation. The concentration of oxygen required to reach a level of 100 percent saturation varies according to pressure, temperature, and salinity. The absolute concentration of dissolved oxygen in arctic waters tends to be higher than in other waters because the solubility of oxygen increases with decreasing water temperature. This generality applies to clear-water streams and clear-water (larger) lakes within the Plan Area. Summer concentrations of dissolved oxygen in Colville River system lakes, creek, and rivers range from 8 to 12 mg/L by weight (Kogl 1971).

Colored-water streams, ponds, and lakes in the Arctic, however, generally have lower dissolved oxygen concentrations. Oxygen-saturation values in Plan Area ponds during the summer months generally fall below 100 percent, although a range between 60 and 118 percent has been observed (Prentki et al. 1980). Oxygen values can be much lower (less than 10 percent saturation) in vegetated shorelines or in water pooled on wet tundra (BLM 1998). In these locations, chemical processes in the underlying sediment deplete oxygen from the water as rapidly as the water can take up oxygen from the air.

In winter, in deeper lakes of the Arctic Coastal Plain, waters remaining beneath the ice tend to become supersaturated with oxygen (Prentki et al. 1980, O'Brien et al. 1995). During ice formation, dissolved oxygen is excluded from the freezing ice into the water column. Exclusion adds more oxygen than underwater respiration by benthic organisms removes. In general, however, the occurrence of supersaturated dissolved oxygen concentrations is less common in Plan Area lakes than a decreasing oxygen concentration. Decreasing oxygen concentrations are more likely because the two primary sources of dissolved oxygen, mixing of waters with air and photosynthesis by aquatic vegetation, do not occur in the winter due to inhibiting effects of ice cover and darkness.

The winter oxygen regime typically decreases in lakes where such factors as bathymetry can inhibit mixing. For example, in Lakes M9906, M9913, M9907, and M9915 near CD-1, the dissolved oxygen concentration decreased throughout the winter (URS Corporation 2001). The amount of oxygen that can be held by the water is a function of temperature, salinity, and pressure (gas solubility). Gas solubility decreases with increasing salinity and conductivity and with decreasing pressure. During monitoring in 2001, there was a notable decrease in dissolved oxygen between February and March (levels dropped to less than 1 mg/L in all four lakes), when the most significant increase in ice thickness and corresponding increase in conductivity occurred. Additional monitoring of permitted water withdrawal lakes, conducted in 2003, showed pockets of dissolved oxygen concentrations. Reductions in oxygen concentrations did not appear to inhibit survival of least cisco fish as shown by the recapture of a tagged cisco the following summer (Moulton 2003).

Late winter measurements of oxygen in unfrozen pools in smaller rivers indicate significant residual oxygen (9 mg/L) and 70 to 99 percent saturation (BLM 1998). The Colville River, with deep, connected channels in its delta, also maintains adequate (for fish utilization) to supersaturated winter oxygen concentrations (USGS 2003).

POTABILITY

Potable water is defined as fresh water free from micro-organisms, parasites, and any other substances at a concentration sufficient to present a potential danger to human health. The primary source of potable water for the Plan Area would be surface water. Treatment according to State of Alaska Drinking Water Regulations, 18 AAC 80, is required for any potable drinking water system. Secondary standards provide specific parameters that define contaminant concentrations which must not be exceeded. Additionally, water must have a generally agreeable taste and odor to be considered potable.

Surface water bodies in the Plan Area generally do not meet potable water standards without treatment. Ponds and local streams are highly-colored from dissolved organic matter and iron (BLM 1998). The ADEC Division of Environmental Health advises that surface waters in Alaska are likely to be contaminated with intestinal wastes from birds, animals, and man, and should be treated before consumption (ADEC 2003). Fecal contamination from avian, caribou, and lemming populations is the primary source of water quality reduction below drinking water standards for fecal coliform in small water bodies in the Plan Area (BLM 1998). Larger lakes and rivers with higher water volumes tend to be less contaminated with fecal coliform; however, fecal contamination may occur locally in areas surrounding long-term campsites and cabins because of inadequate sewage disposal. Low concentrations of fecal coliform colonies were detected in less than 5 percent of discrete water quality samples taken in the Colville River near Umiat and Nuiqsut from 1953 through 1981; no fecal coliform was detected in the remaining samples (USGS 2003).

SOURCES OF OIL AND HYDROCARBONS IN THE NATIONAL PETROLEUM RESERVE-ALASKA

Naturally occurring surface oil seeps are well documented on the North Slope. There are several known seeps in the Plan Area (BLM 1998), including those at Oil Lake and Fish Creek. The peat that underlies the North Slope carries substantial hydrocarbon content. This content is evidenced by: natural sheens that occur in ponds or flooded footprints in the tundra or in the foam on the downwind shoreline of lakes on windy days, and elevated hydrocarbon levels in sediments with peat. These phenomena result from the naturally occurring oil seeps and are not the result of industrial activities. The Colville River drainage includes coal and oil-shale outcrops, the oil seeps, and peat. An oil seep at Umiat along the Colville River led to Navy exploration at that site in 1944 (USGS 2001). The North Slope has reserves of Bituminous and Subbituminous coalthat could be developed in the foreseeable future; however, analyses by the DOE’s Energy Information Administration, indicate this is unlikely due to accessibility and recovery factor constraints (DOE 1999).

TRACE METALS

Pond, lake, and river waters on the North Slope are, in general, low in trace metals compared to most temperate-zone fresh waters (Prentki et al. 1980). However, the water quality conditions of the Colville River do not always meet water quality criteria set by the ADEC. Naturally occurring copper, zinc, cadmium, and lead have commonly been found at concentrations above the criteria established to protect aquatic life from toxic effects (ADEC 2002, USGS 2003). These metals come from the soils in the undeveloped watershed. The variations in water quality are part of the natural environment for fish and wildlife in the Colville River Delta and do not result from man-made disturbances (USACE 1998).

ORGANIC NUTRIENTS

The primary nutrients required for algae productivity and availability of food for fish are nitrogen and phosphorus. The nutrient regimes of the freshwater and marine environments reflect and respond to seasonal climatic extremes (Schell 1975). In the summer, relatively high concentrations of nutrients exist in the Colville River until the water reaches Harrison Bay, where phytoplankton communities consume most of the nitrate. Nitrogen concentrations are generally higher in the spring than in the fall because freezing concentrates nutrients in the water bodies. Another source of organic nutrients is regeneration of ammonia (a preferable source of nitrogen compared to dissolved organic nitrogen) through the conversion of dissolved organic nitrogen by heterotrophs under the winter ice (Schell no date).

Although low concentrations of nitrogen are the limiting factor in phytoplankton productivity in coastal marine water, fresh water in the rivers is primarily phosphate limited. Even though the Colville River is able to support an abundant fishery, phosphate concentrations in freshwater bodies are generally very low (Schell 1975). In the seawater, however, phosphate concentrations are usually higher.

Nutrient levels in lakes and ponds are much lower than in the Colville River. Samples taken in 1971 had nitrate and nitrite concentrations that were almost undetectable in lake and pond water (Alexander et al. 1975). Phosphate concentrations were also much lower in lakes and ponds than in the Colville River.

ESTUARINE WATER QUALITY

Many small bays along the coastline within the Plan Area appear to be old thaw-lakes that have since connected with the Beaufort Sea. The Kogru River is an example of a coastal area where thaw-lakes apparently have joined together to form a bay about 18 miles-long. Water quality in these estuarine waters changes seasonally because of ice cover, wind-driven mixing and storm surges, and fresh water drainage during spring break-up.

SALINITY

The basic characteristics of the bays and coastal waters are summarized in reports by Barnes, Schell, and Reimnitz (1984) and in reports for the Outer Continental Shelf Environmental Assessment Program (OCSEAP)(USDOC, NOAA, 1978, 1984, 1987, 1988). These reports explain that all of the National Petroleum Reserve-Alaska bays and lagoons are very shallow, and all are shoreward of the 10-meter isobath (line of equal bathymetry or water depth). The circulation in this shallow water during the summer is wind-driven and rapid. Circulation is very slow under the winter ice cover. Summer values of salinity in Harrison Bay and Simpson Lagoon vary in the wide range of 10 to 6 ppt, dropping rapidly to fresh water as the river channels in the Delta are approached (Schell et al. 1971).

As the flow from the Colville River decreases in early fall and storm surges associated with westerly winds occur, fresh water left in the Delta channels from the summer flow is gradually replaced by seawater (Schell et al. 1971). The denser salt water flows inward along the channel bottom with accompanying outflow of fresh water into Harrison Bay on the surface. The principal result of the saltwater intrusion is to create isolated marine environments in separate channels. Historically, marine water intrusion has occurred during winter with salt water reaching as far upstream as Ocean Point; however, recent measurements upstream in the Colville River reveal that this phenomenon does not occur every year. Storm surges are more important in the water exchange process during the summer, because although this is a tidally influenced area, lunar tides along the North Slope are very small, averaging 20 to 30 centimeters (8 to12 inches) (Norton and Weller 1984, Selkregg et al. 1975). In the winter however, ice restricts water movement from storm surges, and lunar tides have a larger effect.

TURBIDITY

The rivers on the North Slope of Alaska are partly or wholly frozen for 6 to 9 months of the year, with the result that almost all of the yearly flow is restricted to short spring and summer periods. The great seasonality of the water and suspended sediment flow regimes is reflected in the fact that 43 percent of the annual flow and 73 percent of the total inorganic suspended load of the Colville River were discharged during a 3-week period at spring break-up (late May to early June) (Telang et al. 2003). Suspended-sediment samples taken along the Colville River in 1970 showed an increase in suspended load and percent sand and mud as the flow gradient of the river decreases abruptly at the mouth of the Nigliq Channel. This sharp decrease is indicative of a high rate of sediment deposition within the Delta (Dygas et al. 1971).

MARINE WATER QUALITY

SALINITY

When seawater freezes, only the water molecules form ice; the salt is cast-off as brine into the underlying water column. The brine does not drain or flush out of the shallow bays; instead, it collects on the sea floor, gradually raising the salinity level from 32 to more than 100 ppt in some seafloor depressions (Schell 1975, Newbury 1983). Where the access to open seawater is relatively unrestricted, the circulation of less saline water into the bay and the draining of hypersaline water from shallow, near-shore, under-ice waters is quite rapid. A combination of tidal pumping and density currents accounts for the rapid exchange rate (Schell 1975).

TURBIDITY

Turbidity values in the near-shore Beaufort Sea are dependent on wind- and wave-induced turbulence that resuspends bottom sediment and material discharge from the Kuparuk and Colville Rivers. Therefore, in the winter, under-ice turbidity of marine waters is at its lowest outside the area of ice gouging and strudel scours, a phenomenon that could resuspend bottom sediment. The highest turbidity values are found during spring break-up and periods of heavy precipitation when river discharge is high, resulting in turbid plumes that are discharged into the near-shore coastal waters. The farther offshore, the less influence will be felt on turbidity values from coastal erosion and the Colville River discharge of sediment. Suspended sediment concentrations in the near-shore waters may range from 30 to more than 300 mg/L (MMS 2002). In the winter, suspended-sediment concentrations may range from about 2 to 70 mg/L.

3.2.3 Atmospheric Environment

3.2.3.1 Climate and Meteorology

The Plan Area is within the Arctic Coastal Zone, the northernmost of three climatactic zones on the North Slope. Winters (typically October through April) are long and cold and summers (typically May through September) are short and cool. The climate is one of the harshest environments in North America, where snow might fall even in August. The average daily temperature falls below freezing more than 200 days per year in Nuiqsut. In the Plan Area, the temperatures are warmer than those farther inland on the North Slope; with less precipitation consisting predominantly of snow, although the maximum precipitation is in August. Snow cover has a large seasonal cycle and varies substantially from year to year. Seasonal snow cover on the North Slope can begin in late September to early October and might not disappear until May through mid-June. Interannual variations in the timing of snowmelt are due to variations in polar and arctic weather patterns and associated winds. Climatic conditions for the three climate zones on the North Slope are shown in Table 3.2.3-1.

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures is presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). Data was collected at the Nuiqsut ambient air quality monitoring station for the period April 1999 through March 2003. It shows the annual mean temperature is approximately 12 degrees Fahrenheit (°F) in the Plan Area. A temperature climate summary for the Plan Area is provided in Table 3.2.3-2. Temperatures on the North Slope are typically below freezing from mid-October into May. Heavy construction work and oil exploration are conducted in many areas in winter because both the ground and the streams are frozen hard enough to allow the use of heavy equipment. February is the coldest month, with an average temperature of approximately -16°F. July is the warmest month, with an average temperature of 47°F.

Average snow depth from January through April is 10 inches in Barrow and 15 inches in Umiat, which is in the foothills. The USGS collected snow data in the National Petroleum Reserve-Alaska from 1977 to 1979 and from 1982 to 1983. Snow depths ranged from 0.85 to 1.4 feet during this period of record. Annual average snow depths at several monitoring stations on the coastal North Slope are shown in Table 3.2.3-3, along with other climatological data for the region. It shows snowfall is greatest in October in the Arctic Zone but can occur during any month of the year.

TABLE 3.2.3-1 CLIMATIC CONDITIONS IN ALASKA NORTH OF THE BROOKS RANGE

	Arctic Foothills	**Arctic Inland**	**Arctic Coast**
Distance to the ocean (miles)	93–186	93–124	<12
Elevation (feet)	984–3,281	164–1,312	<164
Air Temperature (°F)			
Mean annual	16.5	9.7 ±0.7	9.7 ±0.7
Degree-Day (°F-day)			
Freeze	7,232	9,572	8,906
Thaw	1,472	1,706	788
Precipitation (inches)			
Snow	6.1	5.0	4.5
Rain	6.6	4.1	3.4
Annual total	12.8	9.0	7.8
Seasonal Snow Cover			
Average starting date	27 Sep.	1 Oct.	27 Sep.
Range	11 Sep. to 15 Oct.	19 Sep. to 12 Oct.	4 Sep. to 14 Oct.
Average duration (days)	243	236	259
Range (extreme)	226 to 261	198 to 260	212 to 288
Average maximum thickness (inches)	-	16.9	12.6
Range (extreme)	-	28 to 70	10 to 83
Thaw season			
Average starting time	28 May	25 May	6 Jun.
Range (extreme)	18 May to 15 Jun.	28 Apr. to 6 Jun.	26 May to 19 Jun.
Average length (days)	122	129	106
Range (extreme)	104 to 139	105 to 167	77 to 153

Source: BLM 1998

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures is presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). Data was collected at the Nuiqsut ambient air quality monitoring station for the period April 1999 through March 2003. It shows the annual mean temperature is approximately 12°F in the Plan Area. A temperature climate summary for the Plan Area is provided in Table 3.2.3-2. Temperatures on the North Slope are typically below freezing from mid-October into May. Heavy construction work and oil exploration are conducted in many areas in winter because both the ground and the streams are frozen hard enough to allow the use of heavy equipment. February is the coldest month, with an average temperature of approximately -16°F. July is the warmest month, with an average temperature of 47°F.

Prevailing northeasterly winds are strongest during winter, often creating blizzard conditions. Southwesterly winds occasionally break this pattern with penetration of mid-latitude storms into the region. The annual mean wind speed is approximately 12.8 miles per hour(mph) (see Table 3.2.3-3). Nuiqsut exhibits a strong bimodal wind direction distribution dominated by northeasterly through easterly directions approximately 45 percent of the time and south–southwesterly through westerly directions the remainder of the time (SECOR International Inc. 2003). Recent quarterly data collected at the Nuiqsut Ambient Air Quality Monitoring Station show a mean 10-meter wind speed of 11.4 mph and a maximum hourly average wind speed of 32.4 mph.

Plume dispersion and diffusion in general is a function of turbulence in the near-surface layer of the atmosphere. When the lower atmosphere is in thermal equilibrium (that is, warmer air on top, colder air on the bottom) and wind speeds are low, there is less plume dispersion and conditions are termed “stable.” When wind speeds are higher, like those in the Plan Area, conditions are more neutral, and plume dispersion improves. With increased surface heating from the sun, dispersion characteristics shift to an unstable pattern because heated air near the ground rises and turns the lower atmosphere over, thereby inducing additional mixing. Table 3.2.3-4 summarizes the frequency distribution of stability class for the Plan Area. As expected, the table shows the Plan Area is dominated by neutral stability conditions and good plume dispersion. The upper boundary of the lower atmosphere is referred to as the “mixing height” for atmospheric modeling purposes. The mixing height is defined as the distance above the surface within which dispersion of air emissions takes place. The mixing height is typically at the vertical location in the atmosphere where a thermal inversion occurs, thus “capping” vertical motion in the lower atmosphere. Mixing heights are defined through meteorological measurements. Since these measurements require sophisticated vertical temperature measurements (i.e., radiosonde), data availability is typically very sparse and commonly collected at major airports or military installations. For the Plan Area, the nearest mixing height database is from Barrow. It is the Barrow mixing height data that has been used for air quality modeling for the air quality operating permits for the production pads CD-3 and CD-4.

CLIMATE CHANGE ON THE NORTH SLOPE

Carbon dioxide (CO_2) is associated with greenhouse gas emissions, along with other gases such as methane. Greenhouse gases are vital to life on earth because they help to maintain ambient temperatures. However, increasing greenhouse gas emissions augment this effect and contribute to overall global climatic changes, typically referred to as global warming. Anthropogenic CO_2 emissions are a product of fossil fuel combustion. Natural processes such as zooplankton and phytoplankton respiration, photosynthesis and vegetative decay, forest fires and volcanic eruptions also contribute substantially to the global CO_2 emissions inventory. Global warming could ultimately contribute to a rise in sea level, destruction of estuaries and coastal wetlands, and changes in regional temperature and rainfall pattern, with potentially major implications to agricultural and coastal communities.

Global temperature is predicted to rise 3 degrees Centigrade (°C) (5°F) in the next 100 years, and could even rise higher (BLM and MMS 1998a). Many scientists believe this increase is associated with increasing global greenhouse gas levels. Computer models indicate that such increases in temperature will not be equally distributed globally, but are likely to be accentuated at higher latitudes, such as in the Arctic, where the temperature increase could be more than double the global average (BLM and MMS 1998a). Warming during the winter months is expected to be higher than during the summer. Northern areas would also likely experience increased precipitation (BLM and MMS 1998a).

TABLE 3.2.3-2 NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM TEMPERATURE CLIMATE SUMMARY (PERIOD OF RECORD APRIL 9, 1999 THROUGH MARCH 31, 2003)

2-Meter Temperature (°F)									
	Mean[1]			Extreme					
Month	Max Daily (Mo. Avg)	Min. Daily (Mo. Avg)	Monthly	Record High (Hr. Avg)	Year	Day	Record Low (Hr. Avg)	Year	Day
April	6.6	-8.5	0.0	36.5	2002	26	-29.2	2000	4
May	25.1	13.6	19.8	65.3	2002	24	-19.7	2001	1
June	47.5	33.8	40.1	75.2	2000	25	23.0	2000	5
July	54.2	39.7	47.1	82.4	2001	16	29.1	2002	26
August	48.7	37.2	43.0	82.0	1999	5	26.1	2000	27
September	39.8	30.3	34.7	65.8	2002	5	7.5	1999	30
October	18.6	9.5	14.5	35.1	2002	3	-17.0	1999	31
November	5.1	-6.9	-0.6	32.5	2002	1	-31.9	1999	5
December	-6.5	-17.5	-11.9	27.5	2001	28	-43.8	1999	18
January	-9.1	-21.3	-15.2	10.9	2003	22	-45.6	2002	23
February	-10.0	-21.8	-15.5	5.2	2003	8	-45.4	2001	25
March	-8.7	-20.9	-14.8	17.6	2003	6	-40.0	2003	26
Monitoring Period	17.6	5.6	12	82.4	2001		-45.6	2002	

Sources: SECOR International, Inc. 2002, 2003; Nuiqsut Ambient Air Quality Monitoring Program Annual Report 2003
Notes:
[1] Nuiqsut Ambient Air Quality Monitoring Program 1999 to 2003.

TABLE 3.2.3-3 REGIONAL CLIMATOLOGICAL NORMALS (1971–2000)

Month	Avg. Minimum Temperature (°F)	Avg. Maximum Temperature (°F)	Avg. Temperature (°F)	Avg. Precipitation (inches)[a]	Avg. Snowfall (inches)[a]	Avg. Snow Depth (inches)[a]	Mean Wind Speed (mph)[b]
January	-19.6 to -23.4	-7.7 to -11.5	-13.7 to -17.5	0.11 to 0.18	2.3 to 2.5	7 to 9	12.5
February	-22.0 to -25.3	-9.8 to -14.0	-15.9 to -19.7	0.13 to 0.15	2.1 to 2.4	7 to 10	13.1
March	-20.0 to -22.4	-7.4 to -9.2	-13.7 to -15.8	0.08 to 0.13	1.9 to 2.3	8 to 11	12.7
April	-7.3 to -9.4	6.1 to 6.3	-0.5 to -1.7	0.10 to 0.17	2.5	8 to 11	12.9
May	15.3 to 15.5	24.9 to 27.3	20.1 to -21.4	0.03 to 0.15	1.2 to 1.9	4 to 6	12.0
June	30.4 to 31.1	39.5 to 45.8	35.0 to 38.5	0.35 to 0.37	0.7	0 to 1	11.4
July	34.3 to 37.5	46.5 to 56.1	40.4 to 46.8	0.80 to 0.90	0.0 to 0.3	0	12.7
August	33.8 to 36.1	43.6 to 51.5	38.5 to 38.7	1.04 to 1.19	0.4 to 0.7	0	13.3
September	27.1 to 27.5	34.8 to 38.2	31.2 to 32.7	0.52 to 0.65	3.7 to 4.1	0 to 1	12.2
October	7.7 to 9.8	19.2 to 19.3	13.5 to 14.6	0.33 to 0.46	7.0 to 8.5	3 to 4	13.4
November	-6.4 to -10.7	1.5 to 4.6	-0.9 to -4.6	0.11 to 0.23	3.3 to 3.5	5 to 7	14.1
December	-16.4 to -20.2	-4.7 to -8.6	-10.6 to -14.4	0.11 to 0.16	2.3 to 3.2	6 to 8	13.0
Annual	3.6 to 5.0	15.8 to 16.9	10.3 to 10.4	3.88 to 4.57	29.2 to 30.6	4 to 6	12.8

Sources: Western Regional Climate Center; Alaska Climate Research Center

Notes:

[a] Monthly Climate Summaries for Barrow WSO Airport (9/2/49 to 12/31/02) and Kuparuk, Alaska (2/1/83 to 12/31/02).

[b] Mean wind speed at Barrow WSO Airport (1996 to 2002) Latitude: 71°17 Min. N; Longitude: 156°46 Min. W; Elevation: 30.8 feet.

TABLE 3.2.3-4 FREQUENCY DISTRIBUTIONS OF ATMOSPHERIC STABILITY CLASS MEASUREMENTS AT NUIQSUT 1999–2001

Stable Category	Frequency %
Extremely Unstable (A)	5
Unstable (B)	4
Slightly Unstable (C)	12
Neutral (D)	67
Slightly Stable (E)	9
Stable (F)	3

Source: SECOR International, Inc. 2003

Changes in permafrost are an important indicator of climate change. Temperature data for permafrost in Alaska has been collected from borings over the last two decades. Using oil exploration wells distributed in the Arctic Coastal Plain and the foothills, Lachenbruch and Marshall (1986) measured the temperatures of permafrost to depths of more than 600 feet and showed that the mean surface temperature is likely to have warmed 2° to 4°C during the last few decades to a century. The Alaska Climate Research Center (2003) reports no increases over 5°F during the last three decades at any of Alaska's first-order weather stations for the period of 1971 to 2000. As discussed in Section 2.3.7.1, ice road construction is necessary during construction and development-drilling phases, and can commence once the depth of frozen ground reaches 12 inches, accompanied by 6 inches of snow cover. It is unknown what impact, if any, a 2° to 4°C increase would have on ice road construction and maintenance. Potential impacts from an increase in mean surface temperature include preventing ambient temperatures from reaching levels cold enough for fast ice road construction, and shortening the season length as a result of earlier spring break-up and subsequent melt. If the ice road season is shortened due to an increase in mean surface temperature, construction and development-drilling schedules would be modified, or appropriate measures, such as the use of road insulating materials, may be proposed to extend the season. Future climate changes could potentially affect a number of meteorological conditions in coastal regions such as the North Slope. These conditions include frequency and intensity of storms, storm surges, and flooding. Changes in weather patterns could potentially result in a greater frequency of stronger storms. Melting ice reserves, and subsequent changes in mean sea level, could potentially increase the frequency of storm surges of a given height. Rising river and sea levels from climate change could also result in increased frequency and intensity of flooding. Although there has been no evidence to correlate an increase in storm activity with climate change, studies continue to investigate the potential role that climate change may have on future meteorological conditions.

EFFECT OF TOPOGRAPHY

Figures depicting geographic features including lakes, rivers, and villages are presented on Figures 1.1.1-1 and 3.2.2.1-1. The regional topography of the Plan Area is relatively flat with little general influence on wind patterns (Section 3.2.1.1 for a detailed description of terrain). Wind speed and direction are typically influenced at ground level by significant features such as deep valleys (i.e. channeling effect) or mountains (i.e. leeward effect). No such features exist in the Plan Area. Local air drainage or stagnation in local low-lying areas could occur under inversion conditions. Such lower boundary layer topographic features do not affect atmospheric motion typical of wind conditions.

The Plan Area is depicted on Figure 1.1.1-1 and described in Section 1.2.1. The 890,000-acre Plan Area's eastern boundary is the Colville River Delta just west of its easternmost channel. The boundary extends southwest, following the Colville River. The southern boundary is the township line between Ts. 7 and 8

N., Umiat Meridian. The western boundary is the township line between Rs. 2 and 3 W., Umiat Meridian. The northern boundary is the section lines separating Secs. 31-32 from Secs. 29-30 in T. 15 N., R. 2 W., Umiat Meridian and eastward along the coast to the point of beginning.

3.2.3.2 Existing Ambient Air Quality

The applicant's proposed action will be in an area that is in attainment of all National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) for criteria pollutants (Table 3.2.3-5). The air quality in the Colville River Delta is generally excellent as a result of few anthropogenic and naturally-occurring air pollution sources and excellent dispersion conditions created by prevailing strong winds. Higher particulate loading of the atmosphere tends to occur more in the summer months when there is no snow and ice cover. Wind blown particulate emissions occur in the Plan Area from river banks, sandbars and gravel roads, and occasional tundra fires. Existing air quality in the Plan Area is pristine, and concentrations of gaseous regulated air pollutants are substantially lower than NAAQS and AAAQS. Emission sources in the Plan Area consist mainly of diesel-fired generators in small villages, snowmobiles, and small amounts of local vehicle traffic. Existing emissions sources at the Alpine Development Project's production and drilling areas outside of the Plan Area include the following:

- Gas-fired turbines and heaters
- Incinerators
- Emergency flares
- Standby diesel-fired power generators
- Portable diesel engines and heaters
- Storage tanks
- Fugitive hydrocarbon process emissions
- Mobile sources (vehicle traffic and aircraft)

Most of these emission sources are subject to federal New Source Performance Standards (NSPS) under existing air quality permit conditions administered by the ADEC, with specific requirements for controlling criteria pollutants. Additionally, the sludge incinerators are subject to the National Emission standards for Hazardous Air Pollutants (NESHAP) for the control of mercury. These existing emission sources do not significantly affect the air quality or visibility, nor do they interfere with the attainment of the NAAQS or AAAQS. There are no federally protected Class I wilderness areas or national parks within 100 kilometers of the Plan Area.

At Nuiqsut, existing emission sources consist of diesel-fired electric generators and home heaters, open burning, occasional small aircraft, and vehicle traffic. Regional sources of emissions consist of oil and gas production facilities 30 to 70 miles east of the Plan Area, including Kuparuk, Milne Point, Prudhoe Bay, North Star, Endicott, and Badami.

Additional emission sources would result from the installation of the following new equipment within the Plan Area and are discussed in Section 4:

- Five drill sites (DS) heaters, 20 Million BTUS per hour (MMBtu/hr), gas-fired (one at each satellite pad)

- Two emergency generators, 500 kW, liquid fuel-fired, installed at CD-3 and CD-6, assuming Alternative A is implemented, and all sites except CD-3 are road accessible. If they are not road accessible, then one emergency generator would be added at each of the five sites.

- One power generator, 3.1 megawatte (MW), gas-fired (CD-6)

- One Frame 5 turbine, 36,700 horsepower, gas-fired (ACX3)

- One heater, 30 MMBtu/hr, gas-fired (ACX3)

Background air quality in the area surrounding the Plan Area was obtained from ambient air quality monitoring stations in the vicinity. Two stations were operated at the KRU, one immediately downwind of major combustion sources at APF-1. This data was not included in the permit. The other monitoring site, at DS-1F, was relatively isolated from KRU emission sources, so data collected from DS-1F are conservatively representative of background or regional air quality in the KRU area. Data from DS-1F shows that concentrations of air contaminants are below the NAAQS, as shown in Table 3.2.3-5. The station at DS-1F was located 47 miles east–southeast of CD-1.

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures are presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). The permit condition required collection of 1 year of ambient levels of NOX, sulfur oxides (SOX), paticulate matter less that 10 microns (PM10), and dispersion meteorological data. Data collected at Nuiqsut are representative of background or regional air quality in the Plan Area. The data (Table 3.2.3-6) indicate that air quality is also in compliance with applicable NAAQS and AAAQS for all pollutants and averaging periods, except for a single day's exceedance of the 24-hour PM10 standard in 1999 (prior to the operation of the APF). In this case, elevated particulate concentrations measured on that day were the result of wind-generated dust from the dried exposed banks of the nearby Nigliq Channel.

TABLE 3.2.3-5 MAXIMUM CONCENTRATIONS OF AMBIENT POLLUTANTS MONITORED AT KRU AND NUIQSUT COMPARED TO FEDERAL AND STATE AMBIENT AIR QUALITY STANDARDS

Air Pollutant	Federal and State Standards	Maximum Monitored Concentration (µg/m^3)[a]	
	Concentration/Averaging Time	KRU (DS-1F)[b]	Nuiqsut[c]
Ozone (O_3)	0.12 ppm, 1-hr avg.(235 µg/m^3)	100.0	NA
Carbon Monoxide (CO)	9 ppm, 8-hr avg. (10,000 µg/m^3)	575	NA
	35 ppm, 1-hr avg. (40,000 µg/m^3)	1,035	NA
Nitrogen Dioxide (NO_2)	0.053 ppm, annual arithmetic mean (100 µg/m^3)	4.9	5.6
Sulfur Dioxide (SO_2)	0.030 ppm, annual arithmetic mean (80 µg/m^3)	2.6[d]	0.0
	0.14 ppm, 24-hr avg. (365 µg/m^3)	13.1	2.6
	0.5 ppm 3-hr avg. (1,300 µg/m^3)	55.0	7.8

Table 3.2.3-5 Maximum Concentrations of Ambient Pollutants Monitored at KRU and Nuiqsut Compared to Federal and State Ambient Air Quality Standards (Cont'd)

Air Pollutant	Federal and State Standards	Maximum Monitored Concentration (µg/m^3)[a]	
Particulate Matter (PM$_{10}$)	50 µg/m^3, annual arithmetic mean 150 µg/m^3, 24-hr avg.	11.2 63	8.2 223[e]
Reduced Sulfur (as SO$_2$)	50 µg/m^3, 30-min. no federal standard	8.3[f]	15.7
Lead	1.5 µg/m^3, calendar quarter	NA	NA

Sources: 40 CFR Part 50; CPAI 2002; AAC 1997
Notes:
[a] National and state standards, other than those based on annual average, are not to be exceeded more than once a year.
[b] Maximum concentrations measured during November 1990 to October 1992.
[c] Maximum concentration measured during July 1999 to June 2001.
[d] Minimum instrument detection level.
[e] PM$_{10}$ exceedance was due to wind-generated dust on a very windy day in early fall 1999.
[f] Maximum 1-hour average

Table 3.2.3-6 Nuiqsut Ambient Air Quality Monitoring Program Measured NO$_2$, SO$_2$, and PM$_{10}$ Concentrations April 9, 1999 to March 31, 2003

Annual Average NO$_2$ Concentration (ppm)	Maximum 3-hour SO$_2$ Concentration (ppm)	Maximum 24-hour SO$_2$ Concentration (ppm)	Annual Average SO$_2$ Concentration (ppm)	Maximum 24-hour PM$_{10}$ Concentration (µg/m^3)		Annual Average PM$_{10}$ Concentration (ug/m^3)	
				Standard	Actual	Standard	Actual
0.008	0.008	0.002	0.000	39.0	33.6	11.2	9.3

Source: SECOR International, Inc. 2003
Notes:
"Standard" refers to measured concentrations based on a flow rate corrected from actual conditions to USEPA-designated standard conditions by using a pressure of 1 atmosphere and a temperature of 25°C

3.2.3.3 Noise

The operation of equipment during exploration, drilling, facility construction (including mining activities) and production and the use of aircraft for transportation of personnel and materials contribute noise to the environment. The Plan Area is remote and sparsely populated with few existing sources of man-made noise. Existing sources of noise include:

- Vehicle operations (Autos, trucks, Ors and snowmobiles) and community noise (generators and other small equipment motors) within the village of Nuiqsut
- Autos, trucks, Ors and snow mobiles used for subsistence hunting and travel among villages and between villages and hunting camps
- Boat operations (outboard motors)
- Aircraft operations at Nuiqsut
- Vehicle operations at CD-1 and CD-2
- Equipment operations at CD-1 and CD-2
- Aircraft operations into CD-1
- Aircraft operations at Colville Village
- Incidental aircraft and boat operations into the regional by recreationists and scientific researchers
- Incidental aircraft operations transiting the Plan Area

Background noise in Nuiqsut, the only community located within the Plan Area, is limited to general community noise, vehicle operations and occasional aircraft operations. The primary non-man-made noise source is the wind. The Noise Control Act of 1972 (and amendments, Quiet Community Acts of 1978, 42 USC 4901-4918) directs individual states to regulate environmental noise and directs governmental agencies to comply with noise standards (statutes and regulations) set by local communities. The State of Alaska and the NSB have not established specific community noise regulations that would govern the noise environment of Nuiqsut. In the absence of a standard set by the community, USEPA guidelines recommend that a day –night sound level ($L_{dn)}$ of 55 decibels on the A-rated scale (dBA) be used as a community noise standard. The level has been determined by USEPA to be sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (USEPA 1972). A second standard, Leq[1] of 70 dBA or less over a 40-year period is recommended by USEPA for protection against hearing loss in the general population from non-impulsive noise. As a reference, the noise generated in a variety of everyday situations that humans could experience is given in Table 3.2.3-7. The USEPA has also published guidelines for noise emissions from certain types of construction equipment including equipment transporters, portable air-compressors and medium- and heavy-duty trucks. The Federal aviation Administration (FAA) has established noise standards for overflight and airport noise, although no standards have been established for civilian helicopters.

---

[1] Leq is the equivalent steady sound level that, if continuous during a specific time period, would represent the same total acoustic energy as the actual time varying sound.

No ambient noise data is available to determine existing community noise levels. However based on the rural character of Nuiqsut and its separation from CD-1 and CD-2 facilities and all ambient noise in the community except for aircraft operations, it is assumed that ambient noise within the community is community generated (by the sources listed above).

At its closest, Nuiqsut is approximately 9.5 miles from CD-1 (which includes the processing facility, APF-1) and CD-2. Power generation and other equipment at CD-1 and CD-2 could result in noise emissions adjacent to this equipment in the range of 85 to 110 dBA. Table 3.2.3-8 lists the typical noise emissions from a variety of equipment typically found in North Slope oil field operations. These noise levels are attenuated as distance from the noise source increases. At 1,000 feet equipment noise emission of 85 to 110 dBA are likely to be 70 dBA or less. They would not contribute any noise at a distance of 9.5 miles to the community noise level in Nuiqsut. It is not anticipated that equipment operating at CD-4 would contribute any noise at approximately 5 miles away.

Residents of Nuiqsut are periodically exposed to aircraft noise both from aircraft operations at the Nuiqsut airstrip and from overflights of the community. Passing fixed wing aircraft (single-engine) would emit a noise level of 66 to 76 dBA (flying at 1,000 feet). Twin-engine planes, transporting operation and maintenance personnel to the CD-3 site, at 1,000 feet would emit a noise level of 69 to 81 dBA. Helicopters typically have noise emissions of between 68 to 78 dBA (flying at 1,300 feet). During takeoff and landings aircraft, especially jet aircraft have much higher noise emissions, however, these higher noise levels occur for a shorter period of time.

While there is little ambient noise in areas away from oil production facilities and population centers, residents of Nuiqsut and other North Slope communities who undertake subsistence harvest activities have expressed concern about the disturbance and flight of subsistence resources (caribou and birds for example) in response to noise generated by construction activities, facility operations, and aircraft operations. As noted previously, noise emissions from fixed place facilities attenuate rapidly with distance from the facility except for the area in proximity to Nuiqsut, CD-1 and CD-2 ambient noise levels are low. Noise from aircraft operations could occur anywhere in the Plan Area but is concentrated near Nuiqsut, CD-1 and Colville Village where airstrips are located. Helicopter flights between facilities on tour of the Plan Area extend short duration higher-level noise emissions into more remote areas.

A noise monitoring program conducted at the Gas Handling Expansion (GHX) Project in the Prudhoe Bay oilfield from 1989 to 91 evaluated the effects of project-related noise on water bird populations, particularly nesting Canada Geese and brood-rearing Brant that inhabit the area annually during May through September (Anderson et al. 1992). The effects of noise from the GHX facility were evaluated by looking for differences in abundance, distribution, and habitat use that could be attributed to avoidance of noise, utilizing different testing methodologies. The study determined that the GHX compressors and turbines contributed to background noise levels mostly at lower frequency ranges at 31.5–63 hertz (Hz). Noise levels on the shore of Prudhoe Bay increased from 1989 to 1991, from an average Leq of 52.2 dBA–54.9 dBA, largely due to gravel-hauling traffic.

Another study was conducted to address the issue of whether noise from the HPE-2 facility, located in the KRU caused a significant impact to waterfowl in the designated wetlands adjacent to the facility (Hampton et al. 1988). The study was limited to construction of the HPF-2 facility, and did not include the ADSP area. From 1985 to 1986, the ambient noise level within the Plan Area was measured at 32 dBA. Hearing sensitivity of birds is known to be between 2 and 3 kilohertz (kHz) (Hampton et al. 1988). During 1985, construction activities, the sound levels averaged 74 dBA, and waterfowl were observed in the study area within 500 meters of the planned site for HPE-2. The estimated average noise level the birds were exposed to in 1985 was 42.4 dBA. During 1986, the noise level ranged from 95 to 105 dBA with installation of one large and 12 portable generators at the pad. Heavy equipment and pipefitting in-creased the noise level to a range of 107 to 128 dBA. Waterfowl were seldom observed with 500 meters of the facility and roads during construction, with the majority of waterfowl observed at least 100 meters from the HPF-2 pad.

TABLE 3.2.3-7 ACOUSTICAL SCALE—TYPICAL NOISE SOURCES

Noise Source	Decibel (dBA)
Turbo jet engine (aircraft)	150
Sonic boom; threshold of pain	140
Pipe organ	130
Jet takeoff at 200 feet	125
Riveter, chipper	120
Night club	115
Motorcycle at 20 feet	110
Power mower	105
Physical discomfort	100
Freight train at 50 feet	95
Propeller plane fly-over at 1,000 feet	90
Electric mixer	85
Freeway traffic at 50 feet; garbage disposal	80
Noisy office	75
Average traffic at 100 feet; vacuum cleaner	70
Air conditioning unit	60
Normal conversation at 12 feet	50
Light traffic at 100 feet; refrigerator	45
Average residence	40
Library	35
Whisper	20
Leaves rustling; threshold of good hearing	10
Threshold of excellent, youthful hearing	0

Source: Plog et al. 1988

However, a greater number of birds utilized habitats in the study area during 1986 than 1985 but at a greater distance from the construction area.

Johnson et al. (2003a) conducted a study to determine, among other things, the effects of noise from air traffic on the greater white-fronted goose nest distribution. It was determined that noise levels from helicopters and airplanes at CD-3 were likely to be less than at the Alpine airstrip because of fewer flights and use by twin-engine planes rather than the noisier four-engine planes used at the Alpine Development Project.

None of the three studies discussed above were limited to observing the effects of noise on avian populations, but rather focused on the combination of visual disturbance (such as air traffic and motor vehicles) and noise. See Section 4A.3.3 for a further discussion.

TABLE 3.2.3-8 TYPICAL OIL FIELD NOISE SOURCES

Source	Noise Level (dBA)	Distance from Source (meters)
HPE-1 (operating)	88–105	0
HPE-1 (flare)	78–82	50
HPE-2 (construction)	95–105	0
Drill Rig	82–92	25
Production Module	88–105	0
Pickup truck	67–75	0
Semi truck	73–85	0
Gravel truck	93–102	0
Helicopter (206B)	115	10

Source: Environmental Science and Engineering, Inc. 1985 to 1986

3.3 BIOLOGICAL RESOURCES

Section 3.3 describes the existing flora and fauna of the Plan Area. This section identifies species that occur in the Plan Area and the habitats they use, summarizes the life histories of important species, and explains their relationship to proposed facilities. This section also addresses the overall North Slope context in which these species occur.

In addition, Section 3.3 identifies federally listed Threatened or Endangered species that occur in the Plan Area; these species are addressed in detail in Section 3.3.5. There are no species in the Plan Area that are listed as threatened or endangered by the State of Alaska.

Further, this section also addresses species on the BLM’s Sensitive Species list for Alaska. Species are placed on this statewide list if (1) their populations are known to be declining or (2) very little is known about them and no formal surveys have been done yet to determine the extent of their range. These BLM Sensitive Species are not federally listed as threatened or endangered; the primary goal of the BLM’s Sensitive Species Policy is to prevent the need to list the species in the future. The BLM Sensitive Species for Alaska are listed in Appendix E.

The animals and plants in the Plan Area occur across the North Slope and in many other parts of Alaska. These species, their habits, and their habitats have been described in detail in recent EISs, EAs, and planning documents with particular bearing on the North Slope including the Plan Area. These documents are incorporated by reference and include the following.

- Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a)
- Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003b)
- EIS for Final Environmental Impact Statement: Renewal of The Federal Grant for the TAPS ROW (BLM 2002)
- CRU Satellite Development Environmental Evaluation Document (EED) (PAI 2002a)
- Alpine Development Project EED (ARCO et al. 1997)
- Alpine Environmental Assessment (PAI 2002b)
- Liberty Development and Production Plan, Final EIS (MMS 2002)
- Beaufort Sea Oil and Gas Development/Northstar Project (USACE 1999)
- Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002)
- Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a)
- The Natural History of an Arctic Oil Field (Truett and Johnson 2000)
- Cumulative Environmental Effects of Oil and Gas Activities on Alaska’s North Slope (NRC 2003)

Relevant information from these documents (and/or references cited in these documents) and other sources is included in the remainder of Section 3.3 and subsequent sections that address biological resources and impacts to those resources.

Furthermore, extensive field studies sponsored by CPAI over several years on a variety of taxa (including Burgess et al. 2000, 2002a, 2002b, 2003a, 2003b, 2003c; Johnson and Stickney 2001; Johnson et al. 2000a, 2000b, 2001, 2002a, 2003a, 2003b, 2003c; Jorgenson et al. 2003; Lawhead and Johnson 2000; Lawhead and Prichard 2002; MJM Research 2001, 2002; Moulton 2001, 2002; Reanier and Associates 2000; URS 2001) have provided much useful information on the biology of the Plan Area.

3.3.1 Vegetation

3.3.1.1 North Slope

The North Slope is bounded on the north by the Beaufort Sea and on the south by the crest of the Brooks Range. The North Slope includes three physiographic provinces that have unique vegetation, topography, geology, and soils: the Arctic Coastal Plain, the Arctic Foothills, and the Brooks Range (Wahrhaftig 1965). These provinces are described in BLM and MMS (1998a), TAPS Owners (2001a), and Nowacki et al. (2001).

The ASDP Area lies entirely in the Arctic Coastal Plain. The Arctic Coastal Plain, also referred to as the Beaufort Coastal Plain by Nowacki et al. (2001), is a flat undulating plain that extends from the Beaufort Sea Coast southward to the foothills of the Brooks Range. This region is dominated by many lakes and poorly drained soils. Permafrost is continuous across the Arctic Coastal Plain, except under large rivers and large thaw-lakes. The permafrost creates an impermeable layer that impedes drainage and perches the water table at or near the surface, resulting in poorly drained saturated soils. For these reasons, nearly the entire region supports wetlands. The Arctic Coastal Plain is characterized by a network of polygonal ground and oriented-thaw-lakes that follow a cyclical pattern of formation and drainage in response to the degradation of ice-rich permafrost (Billings and Peterson 1980; BLM and Ducks Unlimited [DU] 2002).

These large-scale permafrost-related landscape features, and smaller-scale permafrost-related features such as strangmoor ridges, frost scars, and naturally induced thermokarst, are important in creating the relief that determines vegetation patterns on the Arctic Coastal Plain (Peterson and Billings 1978). These processes are detailed further in Billings and Peterson (1980); Peterson and Billings (1980); and BLM and DU (2002). Nowacki et al. (2001) describes the dominant vegetation on the Arctic Coastal Plain as wet sedge tundra in drained lake basins, swales, and floodplains; tussock tundra and sedge-Dryas tundra on gentle slopes; and low willow thickets on well-drained riverbanks.

Many investigations of the vegetation of Alaska’s North Slope have been conducted over the years. For a history and bibliography of these efforts, see Talbot (1996) and the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a).

3.3.1.2 Plan Area

The vegetation of the Plan Area has been mapped most recently by the BLM in cooperation with DU, USFWS, and the NSB (BLM and DU 2002) and by Jorgenson et al. (1997, 2003c). The BLM and DU (2002) digitally mapped the entire National Petroleum Reserve-Alaska from 1994 to 1996 by using Landsat Thematic Mapper imagery and field verification to assess, measure, and document vegetation classes. A portion of the Northeast National Petroleum Reserve-Alaska Plan Area was mapped most recently from 2001 to 2002 with the use of an ecological land survey approach that inventoried terrain units (surface geology, geomorphology), surface forms (primarily ice-related features), and vegetation characteristics (Jorgenson et al. 2003c). The vegetation of the Colville River Delta was mapped from 1992 to 1996 (Jorgenson et al. 1997) using the same ecological land survey approach as in the Northeast National Petroleum Reserve-Alaska study. To present the vegetation classes for the entire Plan Area, the BLM and DU (2002) earth cover classes were linked with similar Jorgenson et al. (1997, 2003c) vegetation classes. Figure 3.3.1.2-1 presents the vegetation classes mapped for the entire Plan Area

(Jorgenson et al. 1997, 2003c; BLM and DU 2002). Table 3.3.1-1 presents the comparison of vegetation classes with earth cover classes. Plant species likely to occur within vegetation classes are described in Table 3.3.1-2.

The USFWS National Wetlands Inventory (NWI) Maps (Harrison Bay A-2, A-3, A-4, A-5, B-1, B-2, B-3, B-4, B-5, C-3, C-4, C-5) show that wetlands and deepwater habitats cover approximately 99 percent of the Plan Area. The USFWS defines wetlands as possessing one or more of the following three characteristics: (1) predominantly supports wetland vegetation; (2) has predominantly undrained hydric soil; and (3) is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al. 1979). The USACE defines wetlands as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas such as tundra. Table 3.3.1-3 presents Cowardin et al. (1997) wetland/upland classifications for the Jorgenson et al. (1997, 2003c) vegetation classes and corresponding BLM and DU (2002) earth cover classes mapped in the Plan Area.

The primary functions of wetlands, as defined by the USACE (1999), fulfilled by Plan Area wetlands include: wildlife habitat, fish habitat, production export, nutrient removal, sediment/toxicant retention and sediment/shoreline stabilization. North Slope wetlands are maintained by continuous permafrost, which limits infiltration (Ford and Bedford 1987), and these wetlands are frozen and snow-covered eight to nine months of the year. In summer, the shallow active layer has minimal capacity for water uptake and permafrost wetlands provide reduced storage for floodwaters and no groundwater recharge function (Senner 1989, Ford and Bedford 1987). Primary values of wetlands, as defined by the USACE (1999), in the Plan Area include: domestic water supply, recreation (subsistence hunting and fishing), education/scientific value, uniqueness/heritage, visual quality/aesthetics and threatened or endangered species habitat.

The BLM maintains a list of sensitive plant species for BLM lands in Alaska. This list was developed in coordination with the Alaska Natural Heritage Program (AKNHP) and includes species of plants with declining populations or species for which there is very little information and for which no formal surveys have been conducted to determine the extent of their range. In addition, the AKNHP maintains a database of Alaska’s rare vascular plants to assist federal and state personnel and other interested parties in identifying and managing these species (Lipkin and Murray 1997). Ten species of plants classified as sensitive by the BLM’s Alaska office and rare by the AKNHP could occur in the Plan Area (Lipkin 2003, pers. comm.). These plant species, their global and state rank, the habitat in which they are likely to occur, and their occurrence in the Plan Area are presented in Table 3.3.1-4. Of these species, only *Poa hartzii* ssp. *alaskana* has been found by rare plant surveys in the area (Jorgenson et al. 2003c). No threatened, endangered, or candidate plant species are known to occur within the Plan Area (USFWS 2003).

The Plan Area can be divided into four ecodistricts that have unique physiographic characteristics and repeating assemblages of terrain units, surface forms, and vegetation: Colville River Delta, Lower Colville Floodplain, Western Beaufort Coastal Plain, and Beaufort Sea Coast (Jorgenson et al. 2003c) (Figure 3.3.1.2-1). The following discussion summarizes the vegetation of the Plan Area by these ecodistricts, as defined and described in Jorgenson et al. (1997, 2003c). The classification and areal extent of Jorgenson et al. (1997, 2003c) vegetation classes with corresponding BLM and DU (2002) earth cover classes mapped in the Plan Area are presented in Table 3.3.1-1.

COLVILLE RIVER DELTA

The Colville River Delta is the largest and most complex delta on the Arctic Coastal Plain of Alaska. It encompasses approximately 15 percent of the Plan Area and is characterized by migrating distributary channels; numerous lakes, ponds, and oxbows; natural levees; sand dunes; sand bars; and mudflats

(Figure 3.3.1.2-1) (Walker 1976, 1983). The outer portion of the Delta is dominated by tidal action, storm surges, and sedimentation from the Colville River. Salt-killed and halophytic vegetation are common. Some of the largest areas of coastal salt marsh on the North Slope are present in the Colville River Delta (Jefferies 1977). The inner portion of the Colville River Delta is less affected by coastal processes, but still includes some salt-affected areas. Coastal barrens occur on river bars, low and tall shrubs grow on slightly higher areas with frequent sedimentation, and dwarf shrub communities occur on well-drained river terraces with marshes in channel ponds.

LOWER COLVILLE FLOODPLAIN

The Lower Colville Floodplain includes the portion of the Colville River floodplain south of the Colville River Delta. The Plan Area boundary follows the western border of the Lower Colville Floodplain west of Ocean Point but includes this ecodistrict to the northeast (Figure 3.3.1.2-1). This region occupies approximately 2 percent of the Plan Area. Barrens occur on river bars, low and tall shrubs grow on areas of frequent sedimentation, alder (Alnus crispa) occurs on the floodplain, and dwarf shrub is uncommon. Higher in the floodplain, wet meadows occur on poorly drained soils that are occasionally flooded and on abandoned floodplain deposits that are rarely flooded (Jorgenson et al. 2003c).

WESTERN BEAUFORT COASTAL PLAIN

The Western Beaufort Coastal Plain encompasses about 77 percent of the Plan Area and lies within the northeastern portion of the National Petroleum Reserve-Alaska The Western Beaufort Coastal Plain is characterized by a flat to gently rolling coastal landscape dominated by thaw-lakes and meandering floodplains of Keolok Creek, Kalikpik River, and the area of Fish and Judy creeks (Figure 3.3.1.2-1) (Jorgenson et al. 2003c). Southeast of the Judy Creek floodplain, the coastal plain is gently rolling with many rather shallow lakes. Wet and moist meadows are found in low-lying areas and swales, and tussock tundra occurs on upper slopes and broad ridges. A gently rolling coastal plain region extends from Fish Creek to the Meade River. Abundant lakes have formed in depressions created by distinctive linear dunes and wet and moist meadows occur in low-lying basins and swales. Tussock tundra occurs on upper slopes, and dry and moist dwarf shrub communities are found on exposed dune ridges. Southeast of Teshekpuk Lake and south of the Kogru River, the coastal plain is relatively flat with abundant but usually small thaw-lakes. Wet and moist meadows occur in low-lying areas and swales while tussock tundra is found on upper slopes and broad ridges (Jorgenson et al. 2003c).

BEAUFORT SEA COAST

The Beaufort Sea Coast encompasses approximately 6 percent of the Plan Area and includes portions of the Central and Western Beaufort Sea Coast ecodistricts as defined by Jorgenson et al. (2003c). The Central Beaufort Sea Coast includes the salt-affected coastal area at the mouth of Fish Creek near the Colville River Delta. The Western Beaufort Sea Coast includes the salt-affected coastal area between the Ikpikpuk River and Fish Creek (Figure 3.3.1.2-1). Salt marshes along the Beaufort Sea Coast are often only a few meters in extent because of the unstable and erosion-prone shoreline (Macdonald 1977). In addition to salt marshes, the Beaufort Sea Coast area is characterized by coastal barrens along beaches and mudflats, coastal wet meadows on mudflats, and coastal lakes and ponds. Brackish thaw-lakes and drained basins are particularly abundant in the Western Beaufort Sea Coast (Jorgenson et al. 2003c).

3.3.1.3 Wildlife Habitats

Several wetland habitats were identified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b) as important to fish, waterfowl, and shorebirds because of the high value or scarcity of these habitats in the region. These wetlands include fish-bearing lakes and streams, riparian shrub lands, and the following classes described by Bergman et al. (1977): shallow and deep Arctophila ponds (Aquatic Grass Marsh), deep open lakes (Deep Open Water), basin-complex wetlands (Young and Old Basin Wetland Complexes), and coastal wetlands (Salt Marsh, Salt-killed Tundra, and Tidal Flat). Wildlife habitat classes developed and described in more detail by Jorgenson et al. (1997, 2003c) are presented on Figure 3.3.1.3-1, with vegetation type and wetland class equivalents in Table 3.3.1-3. Habitat classes have been mapped (Jorgenson et al. 1997, 2003c) for approximately 37 percent of the Plan Area, including all of the Colville River Delta and about 24 percent of the National Petroleum Reserve-Alaska within the Plan Area. These habitat classes have been evaluated for wildlife-habitat relationships within the Plan Area. Habitat preferences of species or species groups are presented in the following descriptions of wildlife resources within the Plan Area.

TABLE 3.3.1-1 COMPARISON OF VEGETATION CLASSES WITH EARTH COVER CLASSES, AND THE AREAL EXTENT OF CLASSES WITHIN THE PLAN AREA

Vegetation Types [1]	Earth Cover Classes[2]	AREAL EXTENT WITHIN ECODISTRICTS IN PLAN AREA[1]									
		Beaufort Sea Coast		Colville River Delta		Lower Colville River Floodplain		Western Beaufort Coastal Plain		Totals	
		Acres	**(%)**	**Acres**	**(%)**	**Acres**	**(%)**	**Acres**	**(%)**	**Acres**	**(%)**
Water	Clear Water, Turbid Water, Ice	39,045	(67.3%)	42,330	(28.9%)	3,900	(25.8%)	120,245	(18.2%)	205,520	(23.4%)
Riverine Complex	not described[3]	0	(0.0%)	0	(0.0%)	0	(0.0%)	698	(0.1%)	698	(0.1%)
Fresh Grass Marsh	*Arctophila fulva*	239	(0.4%)	369	(0.3%)	210	(1.4%)	1,766	(0.3%)	2,584	(0.3%)
Fresh Sedge Marsh	*Carex Aquatilis*	2,787	(4.8%)	32	(0.0%)	377	(2.5%)	37,758	(5.7%)	40,954	(4.7%)
Deep Polygon Complex	Flooded Tundra—Low Centered Polygons	1,699	(2.9%)	3,275	(2.2%)	2,243	(14.8%)	47,991	(7.3%)	55,208	(6.3%)
Young Basin Wetland Complex (ice-poor)	Flooded Tundra—Non Patterned	1,190	(2.0%)	0	(0.0%)	415	(2.7%)	21,306	(3.2%)	22,911	(2.6%)
Old Basin Wetland Complex (ice-rich)	not described[3]	0	(0.0%)	2	(0.0%)	0	(0.0%)	15,673	(2.4%)	15,675	(1.8%)
Wet Sedge Meadow Tundra	Wet Tundra, Sedge/Grass Meadow	3,805	(6.6%)	39,131	(26.7%)	1,874	(12.4%)	141,011	(21.4%)	185,821	(21.1%)
Salt-killed Wet Meadow	not described[3]	7	(0.0%)	6,362	(4.3%)	0	(0.0%)	0	(0.0%)	6,369	(0.7%)
Halophytic Sedge Wet Meadow	not described[3]	486	(0.8%)	3,931	(2.7%)	0	(0.0%)	36	(0.0%)	4,453	(0.5%)
Halophytic Grass Wet Meadow	not described[3]	0	(0.0%)	398	(0.3%)	0	(0.0%)	0	(0.0%)	398	(0.0%)
Moist Sedge-Shrub Tundra	not described[3]	7	(0.0%)	2,880	(2.0%)	0	(0.0%)	41,519	(6.3%)	44,406	(5.1%)
Tussock Tundra	Tussock Tundra, Dwarf Shrub	2,837	(4.9%)	525	(0.4%)	2,850	(18.9%)	201,966	(30.6%)	208,179	(23.7%)
Dryas Tundra	not described[3]	0	(0.0%)	117	(0.1%)	0	(0.0%)	1,242	(0.2%)	1,359	(0.2%)
Cassiope Tundra	Moss/Lichen	491	(0.8%)	0	(0.0%)	3	(0.0%)	7,240	(1.1%)	7,734	(0.9%)

TABLE 3.3.1-1 COMPARISON OF VEGETATION CLASSES WITH EARTH COVER CLASSES, AND THE AREAL EXTENT OF CLASSES WITHIN THE PLAN AREA (CONT'D)

Vegetation Types [1]	Earth Cover Classes[2]	AREAL EXTENT WITHIN ECODISTRICTS IN PLAN AREA[1]									
		Beaufort Sea Coast		Colville River Delta		Lower Colville River Floodplain		Western Beaufort Coastal Plain		Totals	
		Acres	(%)	Acres	(%)	Acres	(%)	Acres	(%)	Acres	(%)
Halophytic Dwarf Willow-Graminoid Tundra	not described[3]	0	(0.0%)	143	(0.1%)	0	(0.0%)	0	(0.0%)	143	(0.0%)
Open and Closed Low Willow	Low Shrub	10	(0.0%)	7,896	(5.4%)	2,741	(18.1%)	2,911	(0.4%)	13,557	(1.5%)
Open and Closed Tall Willow	Tall Shrub	0	(0.0%)	29	(0.0%)	0	(0.0%)	658	(0.1%)	687	(0.1%)
Dune Complex	Dunes/Dry Sand	1,038	(1.8%)	0	(0.0%)	72	(0.5%)	4,804	(0.7%)	5,914	(0.7%)
Partially Vegetated	Sparsely Vegetated	365	(0.6%)	5,300	(3.6%)	204	(1.4%)	4,280	(0.6%)	10,149	(1.2%)
Barrens	Barren Ground/Other	3,539	(6.1%)	33,917	(23.1%)	56	(0.4%)	6,497	(1.0%)	44,009	(5.0%)
no data[4]		430	(0.7%)	0	(0.0%)	160	(1.1%)	1,913	(0.3%)	2,503	(0.3%)
shadow[5]		84	(0.1%)	0	(0.0%)	0	(0.0%)	0	(0.0%)	84	(0.0%)
Total		58,060	(6.6%)	146,637	(16.7%)	15,104	(1.7%)	659,512	(75.0%)	879,314	(100.0%)

Notes:

[1] Vegetation Types and Ecodistricts based on ecological land classifications conducted by ABR, Inc. (Jorgenson et al. 2003).

[2] Earth Cover Classes from BLM and DU (2002).

[3] Some Earth Cover and Vegetation Classes did not correspond well enough.

[4] The vegetation class "no data" refers to areas within the Plan Area that do not overlap with the BLM earthcover shapefile.

[5] The vegetation class "shadow" refers to areas within the Plan Area and BLM earth-cover shapefile where the vegetation type could not be determined because the vegetation was obscured by clouds or shadows or the quality of the spectral signature precluded classification.

TABLE 3.3.1-2 CLASSIFICATION AND DESCRIPTION OF VEGETATION CLASSES IN THE PLAN AREA

Vegetation Types	Description
Water	Permanently flooded, non-vegetated water bodies.
Riverine Complex	Permanently flooded channels and narrow bands or patches of vegetation too small to be mapped separately. Vegetation classes include Water, Barren or Partially Vegetated gravel bars, Fresh Sedge or Grass Marsh, Wet Sedge Meadow, Moist Sedge–Shrub Tundra, or Low Willow Shrub.
Fresh Grass Marsh	Shallow lakes, river ox-bows, shallow margins of large lakes, and shallow water of slow-moving headwater streams. Dominated by *Arctophila fulva*.
Fresh Sedge Marsh	Permanently flooded shallow water, shallow margins of large lakes, and shallow water of slow-moving headwater streams. Dominated by *Carex aquatilis* and could be associated with *Scorpidium scorpioides* and *Eriophorum angustifolium*.
Deep Polygon Complex	Mosaic of vegetation where low-centered polygons have particularly deep (>0.5 meter) centers fringed by Fresh Grass or Sedge Marsh. Broad, low, rims of Wet Sedge Meadow or Moist Sedge–Shrub Tundra separate the centers.
Young Basin Wetland Complex (ice-poor)	Complex mosaic of open water, Fresh Sedge and Grass Marshes, Wet Sedge Meadow, and Moist Sedge–Shrub Tundra in recently drained lake basins characterized by patches too small (< 0.5 hectare) to map individually.
Old Basin Wetland Complex (ice-rich)	Occurring in portions of less recently drained basins and characterized by vegetation found in association with ice wedge development including Wet Sedge Meadow Tundra with low-centered polygons, Moist Sedge–Shrub, and Tussock Tundra. Fresh Grass Marshes are absent and Sedge Marsh occurs only in flooded portions of margins. Complexes comprise at least three vegetation types, with no single type dominant. Minimum size for complexes is 2 hectares.
Wet Sedge Meadow Tundra	Low-lying, poorly drained areas with vegetation dominated by *Carex aquatilis, Eriophorum angustifolium,* and mosses. Associated with nonpatterned ground, low-centered, or disjunct polygons.
Salt-killed Wet Meadow	Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and where salt-tolerant plants are actively colonizing. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium Beeringianum,* and *Salix ovalifolia.*
Halophytic Sedge Wet Meadow	Coastal areas with wet, saline soils typically dominated by the sedges C*arex subspathacea* and *C. ursina.* Associated species often include *Puccinellia phryganodes*, *Salix ovalifolia, Calamagrostis deschampsioides, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.*
Halophytic Grass Wet Meadow	Along the Beaufort Sea Coast, delta margins, and shorelines of tapped lakes and patches among brackish tidal pools and bare mudflats. Dominated by *Dupontia fisheri,* associated with *Puccinellia phryganodes, P. andersonii, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.*
Moist Sedge–Shrub Tundra	Lowland sites on moderately well-drained flats and gentle slopes, frequently associated with high-centered and mixed high- and low-centered polygons. Vegetation is co-dominated by sedges (e.g. *Carex Bigelowii*, *C. aquatilis, Eriophorum angustifolium)*, and dwarf or low shrubs including *Dryas integrifoli*a, *Salix planifolia pulchra,* and *Salix reticulata*.

TABLE 3.3.1-2 CLASSIFICATION AND DESCRIPTION OF VEGETATION CLASSES IN THE PLAN AREA (CONT'D)

Vegetation Types	Description
Tussock Tundra	High-centered and mixed high- and low-centered polygons on broad slopes. Dominated by the tussock-forming sedge *Eriophorum vaginatum.* Associated species could include *Ledum decumbens*, *Vaccinium vitis-idaea, Salix planifolia pulchra, Betula nana, Salix phlebophylla, Dicranum* sp. *Hylocomium splendens, Dryas integrifolia*, *Salix reticulata, Carex Bigelowii*, *Cassiope tetragona, Salix reticulata* and *Tomentypnum nitens.*
Dryas Dwarf Shrub Tundra	Dry, upland, sandy slopes, crests, and well-drained river terraces dominated by *Dryas integrifolia.* Associated species include *Salix glauca, S. reticulata, Arctostaphylos alpina, Arctagrostis latifolia, Thamnolia vermicularis,* and *Cetraria cuculata*.
Cassiope Dwarf Shrub Tundra	Old dunes and banks dominated by *Cassiope tetragona*. *Cassiope*-dominated sites typically are very species rich, common associated species include *Dryas integrifolia, Salix phlebophylla, S. reticulata*, *Vaccinium vitis-idaea*, *CarexBbigelowii*, *Hierochloe alpina,* and *Arctagrostis latifolia*.
Halophytic Willow Dwarf Shrub Tundra	Coastal areas with moist to wet, saline or slightly saline soils typically dominated by *Salix ovalifolia* or co-dominated by *S. ovalifolia* and halophytic graminoids. Associated species include *Carex subspathacea, C. aquatilis, C. glareosa*, *Calamagrostis deschampsioides, Dupontia fisheri, Drepanocladus* sp. and *Thamnolia vermicularis.*
Open and Closed Low Willow Shrub	Riverine, lowland or upland communities dominated by low willows (0.2–1.5 meters) with an open (25–75% cover) or closed (>75%) canopy. Typically dominated by *Salix lanata richardsonii, S. planifolia pulchra,* or *Salix glauca,* with *Carex aquatilis, Equisetum arvense, E. variegatum, Arctagrostis latifolia, S. reticulata, C. Bigelowii, S. alaxensis, Arctostaphylos rubra, Dryas integrifolia*, and *Tomentypnum nitens.*
Open and Closed Tall Willow Shrub	Very well-drained, sandy, and frequently disturbed areas dominated by *Salix alaxensis*. Willows often are >1.5 meters tall with an open (25–75% cover) or closed (>75%) canopy. Understory species could include *Salix lanata, Equisetum arvense, Chrysanthemum bipinnatum, Festuca rubra, Aster sibiricus, Bromus pumpellianus, S. glauca, Arctostaphylos rubra,* and *Astragalus alpinus.*
Dune Complex	Complex formed on inactive sand dunes. Vegetation in moist to wet swales typically is Low Willow Shrub, Wet Sedge Meadow Tundra, or Fresh Sedge Marsh, while dry to moist sandy, dune ridges commonly are Dryas Dwarf Shrub Tundra or Low Willow Shrub.
Partially Vegetated	Riverbanks, upland sand dunes, and shallow lake basins (5–30% vegetative cover). Colonizers include *Deschampsia caespitosa*, *Salix alaxensis*, *Salix lanata*, *Juncus arcticus, Chrysanthemum bipinnatum*, *Stellaria humifusa*, *Elymus arenarius mollis, Equisetum arvense,* and *Trisetum spicatum*.
Barrens	Nonvegetated flats on river bars, sand dunes, tidal flats, and recently drained lake bottoms (<5% cover). Typical species include *Salix alaxensis, Elymus arenarius mollis, Festuca rubra*, *Deschampsia caespitosa, Juncus arcticus, Stellaria humifusa,* and *Equisetum arvense*.

TABLE 3.3.1-3 COMPARISON OF VEGETATION CLASSES, HABITAT CLASSES, AND NATIONAL WETLANDS INVENTORY CLASSES FOR THE PLAN AREA

Vegetation Types[a]	Habitat Class[a]	National Wetlands Inventory Class[b]
Water	Brackish Water (tidal ponds)	E1UBL
Water	Deep Open Water with Islands or Polygonized Margin*	L1UBH, PUBH
Water	Deep Open Water without Islands*	L1UBH, PUBH
Water	Nearshore Water	E1UBL
Water	River or Stream	R1UBV, R2UBH, R3UBH
Water	Shallow Open Water with Islands or Polygonized Margin	PUBH, L1UBH
Water	Shallow Open Water without Islands	PUBH, L1UBH
Water	Tapped Lake with High-water Connection	PUBH, L1UBH
Water	Tapped Lake with Low-water Connection	E1UBL
Riverine Complex	Riverine Complex*	R3UBH, R3USA, PEM1/SS1A, PEM1B
Fresh Grass Marsh	Aquatic Grass Marsh*	L2EM2H, PEM2H
Fresh Sedge Marsh	Aquatic Sedge Marsh	PEM1H
Deep Polygon Complex	Aquatic Sedge with Deep Polygons	PUBH, PEM2H, PEM1F, PEM1/SS1B
Young Basin Complex	Young Basin Wetland Complex (ice-poor)*	PUBH, PEM2H, PEM1H, PEM1/SS1B, PEM1B
Old Basin Complex	Old Basin Wetland Complex (ice-rich)*	PUBH, PEM1H, PEM1F, PEM1/SS1B
Wet Sedge Meadow Tundra	Nonpatterned Wet Meadow	PEM1F
Wet Sedge Meadow Tundra	Patterned Wet Meadow	PEM1/SS1B, PEM1/SS1F
Salt-killed Wet Meadow	Salt-killed Tundra*	E2US/EM1P
Halophytic Sedge Wet Meadow	Salt Marsh*	E2EM1P
Halophytic Grass Wet Meadow	Salt Marsh*	E2EM1P
Moist Sedge–Shrub Tundra	Moist Sedge–Shrub Meadow	PEM1/SS1B
Tussock Tundra	Moist Tussock Tundra	PEM1/SS1B, PEM1B
Dryas Dwarf Shrub Tundra	Upland and Riverine Dwarf Shrub*	Upland, PSS3B
Cassiope Dwarf Shrub Tundra	Upland and Riverine Dwarf Shrub*	PSS3B
Halophytic Willow Dwarf Shrub Tundra	Salt Marsh*	E2SS1/EM1P, E2SS1P
Open and Closed Low Willow Shrub	Moist Sedge–Shrub Meadow	PSS1/EM1B, PSS1B
Open and Closed Low Willow Shrub	Riverine Low and Tall Shrub*	PSS1A, PSS1B

TABLE 3.3.1-3 COMPARISON OF VEGETATION CLASSES, HABITAT CLASSES, AND NATIONAL WETLANDS INVENTORY CLASSES FOR THE PLAN AREA (CONT'D)

Vegetation Types[a]	Habitat Class[a]	National Wetlands Inventory Class[b]
Open and Closed Low Willow Shrub	Upland Low and Tall Shrub	PSS1/EM1B, PSS1B
Open and Closed Tall Willow Shrub	Riverine Low and Tall Shrub*	PSS1C
Open and Closed Tall Willow Shrub	Upland Low and Tall Shrub	Upland
Dune Complex	Dune Complex	Upland, PEM1B, PEM1/SS1B, PSS1B
Barren and Partially Vegetated	Barrens (Riverine, Eolian, or Lacustrine)	Upland, L2USA, PUSD, R2USD, R3USD, E2USN
Barren and Partially Vegetated	Tidal Flat*	E2USN

Notes:

*Represents key wetland habitats that were correlated to Bergman et al. (1977) habitats indentified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b).

[a] Habitat and Vegetation classes from Jorgenson et al. 2003

[b] National Wetland Inventory Classes correlated to the Local Ecosystem Types (adapted from Appendix 8, Jorgenson et al. 2003 from information provided by Joanna Roth and Torre Jorgenson, ABR, Inc.), relationship to Habitat and Vegetation classes could vary; coding based on Cowardin et al. 1979

E1UBL = Estuarine, subtidal, unconsolidated bottom, subtidal
E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded
E2SS1P = Estuarine, intertidal, scrub-shrub, broad-leaved deciduous, irregularly flooded
E2SS1/EM1P = Estuarine, intertidal, scrub-shrub, broad-leaved deciduous and emergent, persistent, irregularly flooded
E2USN = Estuarine, intertidal, unconsolidated shore, regularly flooded
E2US/EM1P = Estuarine, intertidal, unconsolidated shore and emergent, persistent, irregular flooded
L1UBH = Lacustrine, limnetic, unconsolidated bottom, permanently flooded
L2EM2H = Lacustrine, littoral, emergent, nonpersistent, permanently flooded
L2USA = Lacustrine, littoral, unconsolidated shore, temporarily flooded
PEM1B = Palustrine, emergent, persistent, saturated
PEM1F = Palustrine, emergent, persistent, semipermanently flooded
PEM1H = Palustrine, emergent, persistent, permanently flooded
PEM2H = Palustrine, emergent, nonpersistent, permanently flooded
PEM1/SS1A = Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, temporarily flooded
PEM1/SS1B = Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, saturated
PEM1/SS1F = Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, semipermanently flooded
PSS1A = Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded
PSS1B = Palustrine, scrub-shrub, broad-leaved deciduous, saturated
PSS1C = Palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded
PSS1/EM1B = Palustrine, scrub-shrub, broad-leaved deciduous and emergent, persistent, saturated
PSS3B = Palustrine, scrub-shrub, broad-leaved evergreen, saturated
PUBH = Palustrine, unconsolidated bottom, permanently flooded
PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained
R1UBV = Riverine, tidal, unconsolidated bottom, permanent-tidal
R2UBH = Riverine, lower perennial, unconsolidated bottom, permanently flooded
R2USD = Riverine, lower perennial, unconsolidated shore, seasonally flooded/well drained
R3UBH = Riverine, upper perennial, unconsolidated bottom, permanently flooded
R3USA = Riverine, upper perennial, unconsolidated shore, temporarily flooded
R3USD = Riverine, upper perennial, unconsolidated shore, seasonally flooded/well drained
Upland = All areas not defined as wetland or deepwater habitats

TABLE 3.3.1-4 VEGETATION SENSITIVE SPECIES THAT COULD OCCUR IN THE PLAN AREA

Common Name(s)	Scientific Name	AKNHP Rank[a]	Habitat	Occurrence Within Plan Area
Nodding semaphoregrass, Sabine grass	Pleuropogon sabinei*	G4G5 S1	Muddy shores and shallow water	North of Plan Area – Horseshoe Lake area and adjacent sites in Harrison Bay (north and northeast of Teshekpuk Lake)
Alaska bluegrass	Poa hartzii Alaskana*	G3G4T1 S1	Dry sands and gravels of active floodplains	Plan Area – Fish Creek and Judy Creek (also known from sites along the Meade River and from the eastern Brooks Range near Lake Peters)
Ellesemereland whitlow-grass	Draba subcapitata	G4 S1	Dry calcareous, gravelly tundra; pingos	Coastal areas east and west of Plan Area – Prudhoe Bay and Chandler Lake
–	Draba micropetala*	G4 S1	Beach ridges and tundra on eroding coastal bluffs	Coastal areas east and west of Plan Area – Barrow and Lonely
Few flowered whitlow-grass	Draba pauciflora	G4? S1	Mesic tundra and beach ridges	Coastal areas east and west of Plan Area – Barrow and Chandler Lake
Stipulated cinquefoil, Circumpolar cinquefoil	Potentilla stipularis*	G5 S1	Sandy substrate such as sandy meadows and riverbank deposits	South and west of Plan Area – Umiat, Colville site (upriver of Umiat), and from upper Noatak region
–	Oxytropis sordida	G5 S2?	Gravelly substrate along rivers	East of Plan Area – Kuparuk
Drummond's bluebell	Mertensia drummondii*	G2Q S2	Sand dunes	South and west of Plan Area – Kogusukruk River and Meade River
Hairy lousewort	Pedicularis hirsuta*	G4G5 S1	Moist to wet tundra especially lake shores and river banks, on stony or sandy soil	Coastal areas east and west of Plan Area
Pygmy aster–	Eurybia pygmaea* (formerly called Aster pygmaeus)	G3 S2	Sand bars and gravel deposits	East of Plan Area – Kuparuk

Sources: www.uaa.alaska.edu/enri/aknhp_web/index.html and Lipkin 2003, pers. comm.

Notes:

[a] Global Rankings: G2=Imperiled globally, G3=Rare or uncommon globally, G4=Apparently secure globally, but cause for long-term concern, G5=Demonstrably secure globally, G#G#-Global rank of species uncertain and best described as a range between two ranks, G#Q=Taxonomically questionable, G#T#=Glabal rank of species and global rank of described variety or subspecies. State Rankings: S1=Critically imperiled in state, S2=Imperiled in state.

*Identifies vegetation species on the BLM's Sensitive Species List (see Appendix E).

3.3.2 Fish

This discussion incorporates, by reference, the descriptions of the fish resources of the Plan Area included in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and the Colville River Unit Satellite Development Environmental Evaluation Document (PAI 2002a). This section uses these descriptions, augmented by other fish- and habitat-related information, from historical and ongoing research pertinent to this review. Up to and including 1985, Slaybaugh et al. (1989) identified approximately 15 studies that had been conducted in the region of interest. Since then at least 14 additional studies (for example, Moulton 1994, 1996a, 1996b, 1998, 1999a, 1999b, 2000, 2001, 2002; Hemming 1995; MJM Research 2001, 2002) have been conducted on habitats, species descriptions, distributions, and collection sites and methods. These papers and additional studies form the basis for the following discussion. Inupiat names for fish are noted in Table 3.3.2-1, parenthetically after the English name in the subsection titles in Section 3.3.2.4, Fishes of the Plan Area, and after the first mention of the English names of those fish if appearing before Section 3.3.2.4.

TABLE 3.3.2-1 FISH SPECIES LIKELY TO BE FOUND IN THE COLVILLE RIVER DRAINAGE, THE NATIONAL PETROLEUM RESERVE-ALASKA COASTAL STREAMS AND LAKES, AND NEARSHORE COASTAL ZONE

Common Name	Scientific name	Inupiat Name
Anadromous Species		
Arctic cisco	*Coregonus autumnalis*	Qaataq
Bering cisco	*Coregonus laurettae*	Tiipuq
Rainbow smelt	*Osmerus mordax*	Ilhaugniq
Pink salmon	*Oncorhynchus gorbuscha*	Amaqtuuq
Chum salmon	*Oncorhynchus keta*	Iqalugruaq
Amphidromous Species (some remain in fresh water year-round**)**		
Dolly Varden	*Salvelinus malma*	Iqalukpik
Least cisco	*Coregonus sardinella*	Iqalusaaq
Broad whitefish	*Coregonus nasus*	Aanaakliq
Humpback whitefish	*Coregonus pidschian*	Piquktuuq
Freshwater Species		
Arctic grayling	*Thymallus arcticus*	Sulukpaugaq
Burbot	*Lota lota*	Titaaliq
Lake trout	*Salvelinus namaycush*	Iqaluaqpak
Round whitefish	*Prosopium cylindraceum*	Savigunnaq
Alaska blackfish	*Dallia pectoralis*	Iluuginiq
Ninespine stickleback	*Pungitius pungitius*	Kakalisauraq
Slimy sculpin	*Cottus cognatus*	Kanayuq
Northern pike	*Esox lucius*	Siulik
Longnose sucker	*Catostomus catostomus*	Milugiaq

TABLE 3.3.2-1 FISH SOPECIES LIKELY TO BE FOUND IN THE COLVILLE RIVER DRAINAGE, THE NATIONAL PETROLEUM RESERVE-ALASKA COASTAL STREAMS AND LAKES, AND NEARSHORE COASTAL ZONE (CONT'D)

Common Name	Scientific name	Inupiat Name
Marine Species		
Fourhorn sculpin	*Myoxocephalus quadricornis*	Kanayuq
Arctic flounder	*Liopsetta glacialis*	Nataagnaq or Puyyagiaq
Arctic cod	*Boregogadus saida*	Iqalugaq
Saffron cod	*Eleginus gracilis*	Uugaq

Note:
Tables 3.3.2-1 and 3.3.2-2 were compiled based upon reviews of historical scientific studies conducted in the Colville Drainage and Northeast National Petroleum Reserve-Alaska area. They reflect the cumulative research efforts of the past 25 years. They would include: Alt and Furniss 1976; Alt and Kogl 1973; Bendock 1979a, 1979b, 1980, 1981, 1982; Bendock and Burr 1980, 1984a, 1984b, 1985; Craig and Haldorson 1981; Fawcett, Moulton, and Carpenter 1986; Furniss 1974; Kogl 1971; Kogl and Schell 1974; McElderry and Craig 1981; Mecklenburg, Mechlenburg, Thorsteinson 2002; MJM Research 2001, 2002; Moulton 1996a, 1996b, 1999a, 2000, 2002; Moulton and Fawcett 1984; Moulton and Carpenter 1986; Moulton and Field 1991, 1994; Moulton, Field, and Kovalsky 1990; Moulton, Lestelle, and Field 1992, 1993; Moulton, Field, and Brotherton 1986b; Netsch, Crateau, Love, and Swanton 1977; PAI 2002; Philo, George, and Moulton 1993a; Reanier and Associates 2000; URS 2001.

3.3.2.1 North Slope

The North Slope and Beaufort Sea experience subfreezing temperatures for nearly 9 months of the year, and from October to May surface waters of the ocean and freshwater systems are frozen. By late winter, ice cover could reach a thickness of 6 feet. Because rivers, streams, and lake systems of the North Slope are relatively shallow, ice cover can decrease available freshwater habitat by as much as 95 percent (Craig 1989b). In June, rising air temperatures and increasingly longer periods of solar radiation bring about the spring melt, and by mid-July fresh water and nearshore marine waters are usually ice-free. As the summer progresses, air temperatures and solar radiation raise water temperatures to their mid-summer highs. In August, the process begins to reverse. Decreasing air temperatures and rapidly decreasing daylight result in lower water temperatures. First ice typically appears in September, marking the onset of winter.

The seasonal cycle also creates a nearshore marine habitat that is vital to the many migratory fishes of the North Slope. In summer, river runoff coupled with the melting of coastal ice creates warm, brackish (low to moderate salinities) conditions in nearshore areas, particularly near the mouths of rivers (Craig 1984). Marine invertebrates migrate into this brackish nearshore band where they thrive in the warm, detritus-laden shallows. In addition, freshwater invertebrates are washed downstream into the brackish coastal zone. Many of the fishes that overwinter in freshwater habitats and river deltas disperse along the coast to feed in this prey-rich environment that could extend several miles offshore. It has been estimated that of all the marine and freshwater habitat available to fishes during summer, coastal waters hold 90 percent of the exploitable prey biomass (Craig 1989a). It is during this brief summer period that fish achieve most of their yearly growth (Fechhelm et al. 1992; Griffiths et al. 1992) and accumulate fat and protein reserves needed to survive the Arctic winter (Fechhelm et al. 1995, 1996).

Freshwater species seldom use nearshore habitats. When they use these habitats it is predominantly as migration corridors between freshwater systems along the coast.

During winter, the key element for survival in freshwater systems is the availability of unfrozen water (Craig 1989a). By late winter, water bodies less than 6 feet deep freeze to the bottom, except in large river delta lakes. (See further discussion below in Section 3.3.2.2, under Colville River Delta.) Viable habitat is limited to deep lakes and ponds and to the deeper channels and holes within streams and river channels. Deeper waters also must be sufficiently large to sustain many fish for several months. In standing waters, depths of 7 feet are considered the minimum for supporting overwintering freshwater fish (PAI 2002a). The severity of the weather can affect the amount of overwintering habitat. Colder winters or a lack of insulating snow cover can increase ice thickness. Oxygen depletion caused by overcrowding can result in extensive mortality (Schmidt et al. 1989). Craig (1989a) estimated that an increase in ice thickness of only 12 inches could decrease the volume of water at “an average overwintering site” by at least 20 percent; overcrowding can potentially result. Severe winter ice could also freeze portions of the spawning grounds where the eggs of some species are deposited.

Beaufort Sea fishes have adapted four basic life-history strategies that allow them to cope with the seasonal cycles of the Arctic. They could be anadromous, amphidromous, freshwater, or marine.

Anadromous fishes, such as salmon, are hatched and initially reared in freshwater river systems before migrating to sea, where they spend most of their lives (Myers 1949, Craig 1989a). They return to fresh water as adults only to spawn. The Arctic form of anadromy is typically somewhat different from the general case. For example, species like the Arctic cisco (Qaataq) return annually to overwinter in larger river systems of the North Slope, but they remain in the lower reaches where waters are brackish rather than occupy fresh water or the super-cold oceanic waters of the Arctic Ocean (Morrow 1980b).

Amphidromy is a variation of anadromy. In this strategy, fish cycle annually between freshwater habitats in winter and coastal marine environments in summer (Myers 1949, Craig 1989a). Amphidromous fishes spawn and overwinter in rivers and streams but migrate from these freshwater environments into coastal waters during the ice-free summer months to feed. The amphidromous life-history strategy might not be used by all members within a species. Some species could have large amphidromous components, but other sectors of their populations could remain in fresh water year-round and use nearshore waters to migrate to other freshwater systems. Other species could forage extensively in both freshwater and coastal habitats during summer.

Anadromous and amphidromous fishes disperse into coastal waters with the spring break-up. Their distribution is generally confined to the brackish nearshore band (Craig and Haldorson 1981; Craig 1984), although the spatial extent of the summer dispersal depends on species and age. By late summer, decreased solar heating that accompanies the rapidly decreasing daylight, decreased river discharge, and mixing with cold, saline ocean water all contribute to the deterioration of the brackish nearshore. The combination of thermal and photoperiod cues triggers return migrations to spawning and overwintering areas. Movements of amphidromous species within the summer season are often extensive when some fish move considerable distances within the rivers of the Plan Area to accessible deep and shallow off-channel lakes and tundra stream systems. Extensive movements between coastal systems during summer have also been observed (Morris, pers. comm.).

Freshwater species, and those non-migratory components of amphidromous stocks, largely remain within river, stream, and lake systems year-round, although during summer they could venture into coastal areas where waters are brackish. However, for some species summer movements within the rivers of the Plan Area are extensive and directed toward productive, off-channel lake and stream systems in the spring and early summer and toward deepwater overwintering habitats in autumn and early winter.

In contrast, marine fishes spend their entire lives at sea, although some species could migrate into nearshore, brackish coastal waters during summer. Some species, such as fourhorn sculpin (Kanayuq) and Arctic flounder (Nataagnaq or Puyyagiaq), migrate from oceanic-shelf waters to nearshore coastal waters during summer and could even travel considerable distances upriver (Morrow 1980b).

3.3.2.2 Habitats in the Plan Area

The proposed development is within the Colville River Delta, the Fish Creek drainage (including Judy Creek and the Ublutuoch River), and the Kogru and Kalikpik river drainages (Figure 3.2.2.1-2). This region and the nearby coastal zone contain a variety of habitats that support approximately 30 fish species (PAI 2002a). The complex mosaic of river and stream channels and coastal lakes of this area form a highly dynamic system of interconnected habitats (Figure 3.3.1.3-1). These habitats are variously used for overwintering, feeding, rearing, and spawning and as migration corridors.

Four types of lakes predominate in the Plan Area. These have been defined based primarily on the potential for access by fish (Moulton 1996):

- Tapped lake: A lake with an active connection to a river channel during the summer period of high water. The channel is normally a short, low-velocity channel formed when the lake was tapped and drained. Tapped lakes have year-round connecting channels that fish can pass through during summer. However, because most of these lakes are shallow (typically less than 6 feet deep) and drain, they and their channels do not provide winter habitat. Tapped lakes, however, provide excellent rearing habitat during summer and are heavily used by juvenile broad whitefish (Aanaakliq), humpback whitefish (Piquktuuq), and least cisco (Iqalusaaq).

- Drainage lake: Drainage lakes are part of a defined drainage system; that is, there is an active connection to a creek or stream channel. They, like tapped lakes, are used as summer rearing habitat. Although they are typically shallow, drainage lakes, unlike trapped lakes, do not drain as water levels recede.

- Perched lake: These lakes occur at higher elevations and are flooded under high water conditions but do not drain like tapped lakes when floodwaters recede. In perched lakes, survival of fish beyond one summer depends on lake depth. If greater than 7 feet deep, perched lakes could support spawning, and, for some species, all other stages of the life cycle. Perched lakes often lack well-defined connections to stream and river channels. Low-elevation lakes flood every spring during break-up, while those at higher elevations flood less frequently during periods of unusually high water. Perched lakes show a gradation of use depending upon how frequently a lake is inundated by the spring flood. Lakes that are flooded every year or two are typically occupied by broad whitefish and least cisco, but round whitefish (Savigunnaq) and humpback whitefish or almost any species represented in the river (for example, burbot [Titaaliq]) can also occur. Lakes that flood less frequently contain primarily least cisco, with lesser numbers of other species.

- Tundra lake: Tundra lakes are defined as thaw-lakes not within or connected to a river drainage. Tundra lakes thus have little potential for access by fish. Of the 73 tundra lakes that have been sampled in recent years (Moulton 1998), 16 contained ninespine sticklebacks (Kakalisauraq), 2 had Alaska blackfish (Iluuginiq), and 1 had an Arctic grayling (Sulukpaugaq) present.

All of the rivers, streams, and creeks in the region constitute important fish habitat, as do most of the non-tundra lakes, especially the lakes in the Colville River Delta. Figure 3.3.2.2-1 provides an overview of the lakes in the Plan Area that contain fish. Following MJM Research (2001), lakes in which fish presence was verified are divided into those lakes containing species sensitive to habitat changes likely to be associated with project activities (for example, water withdrawal) and those containing species more resistant to such changes. Species sensitive to such activities include whitefishes, ciscoes, salmon, Dolly Varden (Iqalukpik), Arctic grayling, burbot, and lake trout (Iqaluaqpak); resistant species include Alaska blackfish and ninespine stickleback. A high proportion of the lakes containing species that are likely sensitive to project activities are in the Colville River Delta and adjacent to the other rivers in the project area.

The most important fish habitats in the Plan Area are those deeper than 5 to 7 feet, which allows for overwintering. These include river channels and deep lakes. During summer, virtually all streams and lakes that are accessible are used by fish. These ephemeral habitats constitute important rearing grounds and migratory pathways among habitats.

COLVILLE RIVER DELTA

The river channels and lakes of the Colville River Delta, including the Nigliq Channel, provide substantial overwintering habitat to a number of species (e.g., the Nigliq Channel may be one of the primary overwintering sites for Arctic cisco). Within the Colville River Delta, major river-channel habitat includes the Nigliq Channel and the main channel of the Colville River between the Itkillik River and the Kupigruak channels. These channels convey most of the summer flow, as well as hold substantial volumes of water during the winter.

During summer, this habitat constitutes some 47 percent of the surface waters of the Delta. These channels also are used for overwintering and as seasonal migration corridors for freshwater, anadromous, and amphidromous fishes (PAI 2002a). The major channels also are the site of the subsistence and commercial fisheries that are conducted in the Delta during autumn and winter. As noted above, overwintering habitat is crucial to the survival of regional fishes. The deep channels of the Colville River provide the most important fish overwintering habitat on the North Slope. In addition to providing a significant volume of wintering habitat, the Colville River also could have regional significance to broad whitefish for spawning (Morris 2000; Morris 2003, pers. comm.).

In most winters, the main channel of the Colville River ceases to flow, although it largely does not freeze solid. The main channel can support overwintering fish if there is oxygenated water below the ice. Channel depths that can support fish either in pools or a continuous channel will depend on the severity of winter and fall snow cover. In those winters when the Colville stops flowing, denser and colder salt water may move upstream from the coast, in some years as far upstream as Ocean Point. Arctic cisco will migrate upstream with the salt front.

The Nigliq Channel behaves similarly but stops flowing much earlier because of the constriction at the head of the channel. Flow in the Nigliq stops considerably earlier in the winter season compared to the main channel. However, even the Nigliq appears to have sustained flow much later into the winter over the past several years, based on anecdotal information from fishers and researchers (Morris 2004 pers. comm.).

The Colville River Delta is laced with numerous minor channels that, although shallow, transport a substantial volume of water during the spring (PAI 2002a). These channels have low to no flow during summer, and they typically freeze to the bottom during winter. In summer these habitats constitute approximately 13 percent of the surface waters in the Delta. Many species of fish use these minor channels for migration, as well as rearing habitat for juveniles. In mid- to late summer, minor channel habitat contains young-of-the-year and yearling broad whitefish, humpback whitefish, round whitefish, and least cisco.

Large lakes in the Colville River Delta with depths as shallow as 5 feet have the potential to winter fish (Morris 2004, pers. comm.)

Tapped lakes in the Colville River Delta comprise approximately 15 percent of the surface water area in summer.

Drainage lakes in the Delta are those connected to streams that drain into the Colville River. There is only one complex of drainage lakes within the Delta, and these account for only approximately 1 percent of the water surface area within the Delta in summer.

Perched lakes account for approximately 24 percent of the summer water surface area of the Delta, of which approximately 10 percent frequently floods and 14 percent infrequently floods. In the Colville River Delta, approximately 90 percent of the perched lakes are deeper than 8 feet and likely support fish (Moulton 1998). One such perched lake contained an 835-mm-long broad whitefish, possibly the largest specimen of this species ever caught in Alaska (Moulton 1999a).

There are no tundra lakes in the Colville River Delta.

In summary, almost all of the surface waters of the Delta, with the exception of some perched lakes, are used by resident fish. Highest-value habitats include water bodies greater than 7 feet deep, because they provide overwintering habitat. However, the shallow ephemeral stream and lake habitats with stream connections constitute valuable rearing and migratory-corridor habitat The value or significance of ephemeral habitats is often overlooked because of their typically small size and restricted seasonal use. Nevertheless, they are important fish-bearing habitats. Perched lakes, especially those that are deep and flood regularly, are likewise important fish-bearing habitats.

FISH CREEK AND ASSOCIATED DRAINAGES

Stream or river channel habitat in this region is provided by Fish and Judy creeks and the Ublutuoch River. Some areas of these streams are deep enough to allow for overwintering; therefore, they are extremely important fish habitats. Recent summer surveys (for example, Moulton 2000) show that as many as 11 species use Fish and Judy creeks, and at least eight species occur in the Ublutuoch River. These rivers appear to be important habitats for Arctic grayling, all the whitefishes (except round whitefish) and ciscoes, and burbot – all important subsistence species. In addition, the chum salmon (Iqalugruaq) was documented to occur in the Ublutuoch River, and a Dolly Varden was documented in Fish Creek (Moulton 2000). The lower 14 kilometer (km) of the Ublutuoch River (not including lakes) represents the single largest volume of overwintering habitat in the Fish and Judy Creek drainages (Morris 2003). It is used by most species inhabiting the drainage and appears potentially significant for the spawning of broad whitefish and burbot. Large numbers of broad whitefish overwinter in the Ublutuoch River upstream and downstream of the proposed bridge site Morris 2003). Prime feeding and wintering areas have also been reported at the confluence of Fish and Judy creeks.

Drainage and perched lakes also occur in this region and are important fish habitats. However, most of the lakes outside the immediate floodplain of the area rivers are tundra lakes.

KOGRU AND KALIKPIK RIVER DRAINAGES

The Kogru and Kalikpik river drainages have received little attention in historical and recent surveys. The Kalikpik River, however, was sampled in 1983 (Bendock and Burr 1984). The sites sampled reflected stream widths of 40 to 60 feet and maximum depths of 5 to 6 feet. Species documented to have been present include broad whitefish, Arctic grayling, least cisco, and round whitefish. The full complement of species that occur within similar habitats of the region would also be expected to occur in these rivers.

3.3.2.3 Essential Fish Habitat (EFH)

As noted in Alaska Department of Fish and Game (ADF&G), NOAA Fisheries, and North Pacific Fisheries Management Council (NPFMC) (1995), the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act in 1996 to require the description and identification of Essential Fish Habitat (EFH) in fishery management plans, adverse impacts on EFH, and actions to conserve and enhance EFH. Guidelines were developed by the NMFS (now NOAA Fisheries) to assist Fishery Management Councils (Councils) in fulfilling the requirements set forth by the Act. In addition, the Act requires consultation between the Secretary of the Interior (Secretary) and federal and state agencies on activities that could adversely affect EFH for those species managed under the Act. It also requires the federal action agency to respond to comments and recommendations made by the Secretary and Councils.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.). For the purpose of interpreting the definition of EFH, “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and could include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers the full life cycle of a species.

NORTH SLOPE CONTEXT

While there are no federally managed fisheries in the Beaufort Sea, the ranges of the five species of Pacific salmon that are covered under a fishery management plan extend into the Beaufort Sea. Three of these (chinook, sockeye, and coho salmon) are extremely rare, with no known spawning stocks occurring along the northernmost part of Alaska. Spawning populations of pink and chum salmon, however, have been documented. Given these distributions, marine and freshwater habitats of the Beaufort Sea are classified as salmon EFH, albeit the resource level associated with this region is low as compared to more southerly regions of Alaska.

Specifically, salmon EFH has been defined as aquatic habitat (both freshwater and marine) necessary to allow salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. Freshwater EFH for the salmon fisheries in Alaska included all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Alaska. Marine EFH has been defined to include all estuaries and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (EEZ), extending 200 km offshore. Salmon EFH in the fresh waters of Alaska includes virtually all of the coastal streams south of approximately 70°N latitude. Salmon EFH in marine waters is designated as the area within the EEZ down to a depth of 500 meters (NPFMC 1999, as cited in BLM and MMS 2003b). North Slope salmon populations are at the northern extremes of the species ranges. These populations are relatively small and occur only in larger river systems where fish can spawn and eggs don't freeze in gravel (Peltz 2003). Current salmon populations have had a very difficult time establishing and persisting, most likely because of the marginal habitats (Craig 1989, as cited in BLM and MMS 2003b; Fechhelm and Griffiths 2001, as cited in BLM and MMS 2003b).

EFH data are required to be organized by species (five species), life-stage (six life stages have been identified for salmon), and information level:

Level 1: Presence or absence distribution data are available for some or all parts of the geo-graphic range of the species

Level 2: Habitat-related densities of the species are available

Level 3: Growth, reproduction, or survival rates within habitats are available

Level 4: Production rates by habitat are known

An additional level of information, Level 0, has been added to accommodate conditions where no systematic sampling has been conducted for the species and life stages in parts of the known geographic range (NPFMC 1998). This level includes salmon that could have been caught opportunistically in small numbers during research or other activities, but no systematic surveys for salmon life stages have been conducted.

In the Arctic (Region V) there are 30 life stage/species combinations for salmon requiring information. The highest level of information available for any life stage/species in the Arctic Region is Level 1, and 8 of the cells are characterized by Level 0 information. The Arctic Region has the lowest level of salmon EFH information of all the six regions used to characterize Alaska salmon stocks (NPFMC 1998).

PLAN AREA SALMON EFH

As described above, spawning of pink and chum salmon occurs in very low numbers in the Colville River and associated tributaries in the Plan Area. The National Marine Fisheries Act recognizes waters cataloged under AS 16.05.870 (Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes) as EFH (ADF&G 1998). For purposes of this proposed action, Fish Creek (stream number 330-00-10840 in the catalog), Judy Creek (stream number 330-00-10840-2043), the Ublutuoch River (stream number 330-00-10840-2017), and the Colville River (stream number 330-00-10700) are considered EFH for chum and pink salmon. Chum and pink salmon are listed in the catalog as using these four watercourses for migration. No other salmon streams in the area of proposed use are noted in the catalog (ADF&G 1999). The estuarine and marine areas bordering the Plan Area are EFH for all five species of Pacific salmon.

3.3.2.4 Fishes of the Plan Area

This section provides life-history information for the principal fish species that occupy the Plan Area (see Table 3.3.2-1). Table 3.3.2-2 provides summary information for these species; additional details for selected species are provided in the following text. We begin with the anadromous and amphidromous species because of their importance to humans. We next describe the freshwater species of the Plan Area, and last we address the marine species that likely occur in the nearby coastal zone and could travel up rivers during summer and even in winter.

Two freshwater species (threespine stickleback [*Gasterosteus aculeatus*] and Arctic lamprey [Nimigiaq; *Lampetra camtschatica*] occur only as vagrants in the Plan Area (Morris 1980), and four marine species (capelin [Panmigriq or Panmaksraq; *Mallotus villosus*], Pacific herring [Uqsruqtuuq; *Clupea harengus*], Pacific sand lance [*Ammodytes hexapterus*], and kelp snailfish [*Liparis tunicatus*] occur only sporadically offshore (Dew and Mancini 1982; Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Moulton and Fawcett 1984; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1995, 1996, 1997). These species are not included in the below tables nor are they addressed further in the text.

No fish that occur in the Plan Area are listed as federally Threatened or Endangered or as Sensitive Species by the BLM in Alaska.

ANADROMOUS FISH

ARCTIC CISCO (QAATAQ)

The Arctic cisco is one of the most abundant and widely distributed coregonids found in the coastal waters of the Beaufort Sea during summer (Bendock 1979a; Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Fawcett et al. 1986; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Underwood et al. 1995; Griffiths et al. 1997). It is the principal species targeted in the fall subsistence and commercial fisheries that operate in the Colville River Delta (Moulton 1994, 1995; Moulton and Field 1988, 1991, 1994; Moulton et al. 1992, 1993). By virtue of its size, the Colville River is the only system west of the Mackenzie River, Canada, that can support substantial overwintering populations of subadult and adult Arctic cisco (Craig and Mann 1974). The drainage contains approximately 75 km of deep-water, main-channel habitat, much of it in the lower reaches. Moulton (1997) estimated that the number of Arctic cisco greater than 250millimeter (mm) long that overwinter in the Colville River System fluctuates between 200,000 to more than a million fish.

TABLE 3.3.2-2 SUMMARY OF FISH LIKELY TO BE FOUND IN THE PLAN AREA

Species	**Habitat Preferences (includes all life stages)** (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							**Subsistence Fishery** (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	**Notes** (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	**Drainage Lakes**	**Perched Lakes**	**Tundra Lakes**	**Rivers**	**Streams**	**Marine**		
Anadromous Species									
Arctic cisco					F, W, Sp		Su	F, W	Principal target species of fall subsistence and commercial fisheries in Colville River Delta. Abundant and widespread coastally in summer. Could spend most of life in brackish to marine waters, including in winter; likely spawns in Canada's Mackenzie River in fall. Rare in freshwater coastal plain lakes and streams west of Colville River in the eastern National Petroleum Reserve-Alaska and in lakes and streams of Colville River Delta. On Colville River overwintering probably limited to lower reaches and Delta. Move into lower Colville River channels in fall. Yields in Colville River commercial and subsistence fisheries often exhibit positive correlation with salinity. Many Colville River individuals likely spawn in Mackenzie River in Canada and overwinter in larger North Slope drainages. ***See text for details.***
Bering cisco					F, W, Sp		Su	F, W	Of minor importance to the Colville River subsistence fishery (Moulton 2001). Very little known about Bering cisco in Beaufort Sea. Some speculation that fish could be transients from Yukon River or from Russian rivers (Burns 1990). Apparently most abundant near coast in areas of high salinity (Alt 1973), thus considered anadromous. However presence of individuals in spawning condition 1,610 km inland from the mouth of the Yukon River in mid-June suggests either overwintering in middle Yukon or very rapid migration (Alt 1973). Spawn in fall.
Rainbow smelt					Sp		Su, F, W,		Pelagic; throughout Beaufort Sea. Spawn in spring (McPhail and Lindsey 1970; Scott and Crossman 1973). Spawn multiple times; sexual maturity at approximately age 6-8. Can live well into teens (Kendel et al. 1975; Morrow 1980b; Bond and Erickson 1989). Fry carried downriver, emerge into coastal waters by early summer (Kendel et al. 1975; Percy 1975; Ratynski 1983; Bond and Erickson 1987). In Alaskan Beaufort Sea, spawning probably limited to Colville River; other rivers too small to provide open-water and under-ice channels for spring spawning migration. Spawn in lower reaches of Colville River; probably go upstream only enough to reach fresh water (Morrow 1980b; Burns 1990). Aside from spawning, overwinter and summer in brackish coastal areas and deltas. Not normally found in freshwater coastal plain lakes and streams to west of Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002), but reported in low to moderate numbers in river channels and tapped lakes of Colville River Delta (Moulton 1996a, 1996b).

TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

Species	Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	Drainage Lakes	Perched Lakes	Tundra Lakes	Rivers	Streams	Marine		
Pink salmon					YR	Su	Su	(negligible F)	Small runs occur in Colville River (Bendock 1979b; McElderry and Craig 1981). Spawn in the fall. In recent years, “substantial numbers” taken near Itkillik River as part of fall subsistence fishery (George 2001, pers. comm.). A minor portion of total subsistence catch; not a target species (Pedersen and Shishido 1988; Moulton and Field 1988, 1991, 1994; Moulton et al. 1986b, 1990, 1992, 1993; Moulton 1994, 1995, 1996b; George 2001, pers. comm.). Carcasses have been observed on banks of Ublutuoch River (Morris 2003, pers. comm.). ***See also Section3.3.2.3, Essential Fish Habitat.***
Chum salmon					YR	Su	Su	(negligible F)	Small runs in Colville River drainage. Bendock (1979b) reported taking 35 chum salmon in the lower reaches of the river and indicated that spawning occurred in the lower river from mid-August to mid-September. In recent years, smolts have been caught in the lower Delta (Moulton 1999a, 2001). Although chum salmon are taken in the fall subsistence fishery, they constitute only a minor portion of total catch (Pedersen and Shishido 1988; Moulton and Field 1988, 1991, 1994; Moulton et al. 1986b, 1990, 1992, 1993; Moulton 1994, 1995, 1996b, 1997). Small runs also could occur in rivers closer to Barrow. One female chum salmon was captured in a fyke net set in the Ublutuoch River in 2001. ***See also Section3.3.2.3, Essential Fish Habitat.***
Amphidromous Species									
Dolly Varden					YR	Su	Su		Spawn alternate years in mountain streams from Colville River to Mackenzie River where perennial springs provide winter open-water. Sexual maturity at 7-9 years in Arctic. Juveniles remain in natal streams for several years before first migration to sea. Some males non-amphidromous, remaining in natal rivers for entire life. Rare in freshwater coastal plain lakes and streams to west of Colville River in the eastern National Petroleum Reserve-Alaska and in channels, lakes, and streams of Colville River Delta. Amphidromous individuals migrate downriver with spring break-up and disperse into coastal waters. Return migrations to spawning and overwintering areas typically begin in August. Channels of the Colville River Delta are principal migratory corridor; Plan Area not spawning, overwintering, or foraging grounds. ***See text for details.***

TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

Species	**Habitat Preferences (includes all life stages)** (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							**Subsistence Fishery** (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	**Notes** (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	**Drainage Lakes**	**Perched Lakes**	**Tundra Lakes**	**Rivers**	**Streams**	**Marine**		
Least cisco	Su	YR	YR		YR	Su	Su	F, W	Exhibit two life-history patterns: some amphidromous, others strictly freshwater. Some freshwater populations migratory, moving among lakes, streams, and rivers; others non-migratory or lake-dwelling populations. In summer and fall, common throughout coastal North Slope including freshwater coastal plain lakes and streams west of Colville River in eastern NATIONAL PETROLEUM RESERVE-ALASKA; river channels, outer channels, tapped lakes, and perched lakes of Colville River Delta; and abundantly in Beaufort Sea coastal waters. Spawn late September and October in Colville, Ikpikpuk, and Price rivers. Non-migratory forms spawn in sand and gravel; eggs hatch the following spring. Colville River Delta very important least cisco overwintering habitat. Typically overwinters in upper reaches of the Delta. ***See text for details.***
Broad whitefish	Su	YR	YR		YR	Su	Su	Su, F, W	Common summer and early autumn in all coastal North Slope habitats. Juveniles appear intolerant of high salinities. Upstream spawning runs June-September; spawning September-November, over gravel bottoms; adults disperse throughout watershed to overwinter where water depth is sufficient; young hatch the following spring; disperse downriver. Rearing in low-velocity areas throughout middle and lower river. ***See text for details.***
Humpback whitefish	Su	YR	YR		YR	Su	Su	F, W	Range includes Colville River and many rivers farther west. Spawn September and October in Delta and in middle and upper reaches of Colville River. Spawn in moderately swift running water over gravel bottoms in lakes, streams, and rivers. The average life span for Colville River fish probably mid- to upper 20s. Excluding upriver spawning runs, summer distribution within Colville River and National Petroleum Reserve-Alaska appears limited to main river channels, deltas, and low-salinity coastal areas. Generally few in Fish and Judy creeks or in nearby perched lakes during summer. Frequently in river channels and tapped lakes of Colville River Delta, but scarce in perched lakes. Very abundant in outer Delta. Apparently intolerant of high salinities in summer, but could overwinter in the lower Colville River Delta in high salinities. Juveniles appear to remain close to lower Delta***. See text for details.***

TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

Species	Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	**Drainage Lakes**	**Perched Lakes**	**Tundra Lakes**	**Rivers**	**Streams**	**Marine**		
Freshwater Species									
Arctic grayling	Su	Su	Su	YR	YR	Su			Widespread and abundant in Colville River above confluence of east and west delta channels; in main channel, major tributaries, smaller rivers and streams, and many Alpine lakes; however, occurrence is sporadic. Spawn in most of these upstream habitats; exhibit no particular substrate preference. Spawning in main Colville River channels heaviest upstream of confluence with Etivluk River; downstream, spawning more limited to side tributaries and larger stream channels. Far less common in channels, lakes, and streams of lower Delta and in freshwater coastal plain lakes and streams west of Colville River in the eastern NATIONAL PETROLEUM RESERVE-ALASKA. Many adults and subadults use Ublutuoch River to summer and overwinter. In Fish and Judy creeks most strongly associated with tundra drainages and tundra drainage outfalls in main channels. ***See text for details.***
Burbot	Su	YR	Su		YR	Su			In Colville River watershed and coastal lakes and streams of the NATIONAL PETROLEUM RESERVE-ALASKA; typically taken in small numbers. Early surveys could have underestimated their North Slope distribution. Spawn in Colville River near Umiat in late winter. Rearing areas include mouths of minor tributaries of lower Colville River Delta. Appear to spawn in lower Ublutuoch River within Plan Area; move extensively throughout main channel habitats and small tundra drainages during open-water season. ***See text for details.***
Lake trout		YR							In many mountain lakes of Colville River watershed; observed less regularly in main channel, main tributaries, and larger streams of upper system (Kogl 1971; Furniss 1974; Bendock 1979b, 1982). Extremely rare in river channels, streams, and lakes of lower Colville River and Delta and throughout coastal plain east and south of Fish Creek (MJM Research 2001; Moulton 1996a, 1996b, 1999a, 2000, 2002). Widely distributed in coastal plain lakes north and west of Fish Creek in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock and Burr 1984a, 1984b; Philo et al. 1993a). Might wander within lake systems; no defined population migrations (Morrow 1980b). Does not enter coastal brackish waters during summer.

Table 3.3.2-2 Summary of Fishes Likely to be Found in the Plan Area (cont'd)

Species	Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	Drainage Lakes	Perched Lakes	Tundra Lakes	Rivers	Streams	Marine		
Round whitefish	Su	YR	YR		YR	Su			Common in upper Colville River watershed; records from lower reaches of the Anaktuvuk, Chandler, Killik, Itkillik, and Kogosukruk rivers; Shanin and Chandler lakes; and several unnamed lakes and streams of upper Colville River system (Kogl 1971; Furniss 1974 Alt and Kogl 1973; Bendock 1979b; Bendock and Burr 1984a). In Fish Creek, Judy Creek, the Ublutuoch River, and some smaller streams of coastal plain west of Colville River; largely absent from many lakes of eastern National Petroleum Reserve-Alaska (Bendock and Burr 1984a, 1984b; Philo et al. 1993a; MJM Research 2002; Moulton 2000, 2001, 2002). Common in Colville River Delta river channels and tapped lakes; rare in perched lakes (Moulton 1999a, 1999b). Small to moderate numbers taken regularly in coastal waters; distribution restricted to low-salinity areas near river deltas (Griffiths and Gallaway 1982; Fawcett et al. 1986; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Griffiths et al. 1997).
Alaska blackfish	Su	Su	Su	YR	YR	Su			Presence occasional in Colville drainage and the National Petroleum Reserve-Alaska (Bendock and Burr 1980, 1984b; MJM Research 2001, 2002; Moulton 2002), the eastern limit of its northern Alaska range (Mecklenburg et al. 2002). Low numbers in the National Petroleum Reserve-Alaska lake and stream surveys possibly the result of inefficiency of gill nets at capturing small fish (Bendock and Burr 1984b). Thus abundance in many habitats could be underestimated. Few caught in Colville River Delta fyke net surveys in river channels and tapped lakes (Moulton 1999b). Slightly higher numbers caught in high and low perched lakes, but only sporadically.
Ninespine stickleback	Su	Su	Su	YR	YR	Su			Common in lakes and streams of Colville River watershed and the National Petroleum Reserve-Alaska (Furniss 1974; Bendock and Burr 1984a, 1984b; MJM Research 2001, 2002; Moulton 2002). A forage fish for other species. Small size (<75 mm), most probably eluded detection in pre-mid-1990s gill net and angler surveys; usually minnow traps, seines, or fyke nets required (Kogl 1971; Furniss 1974; MJM Research 2001, 2002; Moulton 2002). Thus abundance in many habitats could be underestimated. Found in most river channels, tapped lakes, and perched lakes in Colville River Delta fyke net surveys (Moulton 1999b); the overwhelmingly dominant species collected in both high and low perched lakes.
Slimy sculpin	Su	Su	Su		YR	Su			Common in lakes and streams of Colville River watershed and the National Petroleum Reserve-Alaska (Furniss 1974; Bendock and Burr 1984a, 1984b; Moulton 2002). A forage fish for other species. Small size (<75 mm), most probably eluded detection in pre-mid-1990s gill net and angler surveys; usually minnow traps, seines, or fyke nets required (Kogl 1971; Furniss 1974; Moulton 2002). Thus abundance in many habitats could be underestimated.

TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

Species	Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round)							Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round)	Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.)
	Tapped Lakes	Drainage Lakes	Perched Lakes	Tundra Lakes	Rivers	Streams	Marine		
Northern pike					YR				Limited distribution in Plan Area. In upper Colville drainage, restricted to two lakes in northern foothills of Brooks Range, near upper Killik River (Burns 1990). In Colville River fisheries, taken incidentally in lower part of the river; little evidence of occurrence elsewhere in Colville drainage (Burns 1990). In coastal streams and lakes of the eastern NATIONAL PETROLEUM RESERVE-ALASKA, restricted to middle and upper reaches of Ikpikpuk River (Netsch et al. 1977; Bendock and Burr 1984b; MJM Research 2001, 2002; Philo et al. 1993a; Moulton 2001). Although rare throughout channels, lakes, and streams of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b, 1999a), found in low numbers in several lakes near the mouth of the Itkillik River (Moulton 1998).
Longnose sucker	Su	YR	YR		YR	Su			In main Colville River Channel and many tributaries and smaller rivers of the upper watershed (Bendock 1979b). In Colville River Delta, common in low numbers in stream channels and tapped lakes but rare in perched lakes (Moulton 1999a, 1999b). Rare in coastal plain lakes and streams west of Colville River (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002).
Marine Species									
Fourhorn sculpin					Su		YR		Demersal; in nearshore brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980b). Migrate into brackish coastal habitats during summer to feed; could travel considerable distances up rivers (for example, reported 144 km upstream in Meade River by Morrow 1980b). Small numbers sporadically in Colville River Delta (Moulton 1996b, 1999b); no evidence of major upstream migrations in the eastern National Petroleum Reserve-Alaska or Colville watershed. Numerous in Nigliq Channel in autumn, creating nuisance for fishermen when gill nets touch the bottom (Moulton 2003).
Arctic flounder					Su		YR		Demersal; in nearshore brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980b). Migrate into brackish coastal habitats during summer to feed; could travel considerable distances up rivers. Small numbers sporadically in Colville River Delta (Moulton 1996b, 1999b); no evidence of major upstream migrations in the eastern National Petroleum Reserve-Alaska or Colville watershed.
Arctic cod							YR		Abundant in coastal waters; do not actively move into freshwater or low-salinity habitats (Dew and Mancini 1982; Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Moulton and Fawcett 1984; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1995, 1996, 1997).
Saffron cod							YR		Frequently enter rivers; could go considerable distances upstream. Might be found both nearshore and offshore during summer (Morrow 1980a).

Arctic cisco appear to be truly anadromous in that, except for spawning, they could spend most of their lives in brackish to marine waters, including during the winter (Scott and Crossman 1973; Morrow 1980b). Under-ice winter surveys in the Mackenzie Delta, Canada, (Percy 1975; Mann 1975), the Sagavanirktok River and Delta (Alt and Furniss 1976; Dew 1982; Bendock and Burr 1984a; Adams and Cannon 1987; Schmidt et al. 1989), and the Colville River and Delta (Kogl and Schell 1974; Bendock 1979b, 1981, 1982; Adams and Cannon 1987) rarely report the presence of Arctic cisco in areas where salinities are low. In contrast, relatively large numbers of Arctic cisco are reported in overwintering areas of moderate to high salinity (Craig and Haldorson 1981; Adams and Cannon 1987; Schmidt et al. 1989). Bond (1982) reported that Arctic cisco overwintering in Tuktoyaktuk Harbor, Canada, remain below the halocline (a vertical salinity gradient). In the Colville River, Arctic cisco move into lower river channels in fall as salinity increases after ice formation (Moulton and Field 1988; Moulton 1994). Yields in the Colville River commercial and subsistence fisheries often exhibit a positive correlation with salinity (Moulton et al. 1990, 1992; Moulton and Field 1994). Saline intrusion, however, has not significantly occurred during the past several winters in the Colville River main channel, and subsistence catches have been the lowest on record. Arctic cisco are rare in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska and in the lakes and streams of the Colville River Delta (Netsch et al. 1977; Bendock and Bur 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 1996a, 1996b, 1999a, 1999b, 2000, 2002).

Arctic cisco spawning areas have never been identified in Alaska. Many of the Arctic cisco that inhabit the Colville River likely originate from spawning stocks in the Mackenzie River in Canada (Gallaway et al. 1983; Fechhelm and Fissel 1988; Bickham et al. 1989; Moulton 1989; Fechhelm and Griffiths 1990; Schmidt et al. 1991; Morales et al. 1993; Underwood et al. 1995; Colonell and Gallaway 1997; Moulton 2001). It is hypothesized that in summer, newly hatched fish are transported westward into Alaska by wind-driven coastal currents. Once in Alaska, they take up overwintering residence in some of the larger North Slope drainages such as the Colville and Sagavanirktok rivers. Beginning at approximately age 5 they enter the fall commercial and subsistence fisheries that operate in the lower Colville River and Delta (Moulton and Field 1988, 1991, 1994; Moulton et al. 1992, 1993; Moulton 1994, 1995, 2001). It is believed that once they reach sexual maturity (approximately 7 years old) they migrate back to the Mackenzie River to spawn (Gallaway et al. 1983).

Therefore — given (1) the extremely low numbers of Arctic cisco in coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska and in the lakes and streams of the Colville River Delta during summer, (2) their strong summer abundance in coastal waters, (3) their apparent anadromous nature, and (4) assuming that most fish originate from spawning stocks in the Mackenzie River, Canada — much of the Colville watershed and the lake, pond, and stream systems in the eastern National Petroleum Reserve-Alaska are not important habitat for this species. Overwintering is probably limited to the lower reaches of the Colville River and Delta where waters remain brackish.

BERING CISCO (TIIPUQ), RAINBOW SMELT (ILHAUGNIQ), PINK SALMON (AMAQTUUQ), AND CHUM SALMON (IQALUGRUAQ)

Summary information on these species is in Table 3.3.2-2.

AMPHIDROMOUS SPECIES

DOLLY VARDEN[2] (IQALUKPIK)

Amphidromous Dolly Varden spawn in many of the mountain streams between and including the Colville and Mackenzie rivers (Bain 1974; Craig and McCart 1974, 1975; Smith and Glesne 1982; Craig 1977a, 1977b; Daum et al. 1984; Craig 1984; Everett et al. 1997). They are alternate-year spawners that reach sexual maturity at 7 to 9 years in the Arctic (Morrow 1980b). Spawning occurs in areas where perennial springs provide fish with open-water habitat throughout the winter (McCart 1980; Craig 1984). Juveniles remain within their natal streams for several years before their first migration to sea (Craig 1977a, 1977b, 1977c). There is also a component of the population consisting of non-amphidromous males that remain within their natal rivers for their entire life (Craig 1977a, 1977b).

The Anaktuvuk and Chandler rivers support the greatest numbers of Dolly Varden in the Colville River watershed (Bendock 1980, 1981). Both rivers are fed by a number of perennial springs that maintain open-water leads throughout the winter (Bendock 1982). Dolly Varden also are found in large glacial lakes of the Kurupa, Anaktuvuk, and Chandler rivers (Furnis 1974; Bendock 1979b; Bendock and Burr 1985). Lake-bound resident forms (probably relict Arctic char) inhabit several alpine lakes in the area, and year-round stream residents are also found in smaller streams (Bendock 1979b). Dolly Varden are rare in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002) and in the channels, lakes, and streams of the Colville River Delta (Moulton 1996a, 1996b, 1999a).

Amphidromous Dolly Varden migrate downriver with the spring break-up and disperse out into coastal water to feed (Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1996). They could even migrate out to oceanic waters of the Beaufort Sea shelf to forage (Fechhelm et al. 1997). Return migrations to spawning and overwintering areas typically begin in August. Although the Plan Area does not serve as spawning, overwintering, or foraging grounds for Dolly Varden, the channels of the Colville River Delta are the principal migratory corridors for this species.

LEAST CISCO (IQALUSAAQ)

Least cisco exhibit two different life-history patterns. Some are amphidromous, whereas others are strictly freshwater forms (McPhail and Lindsey 1970; Scott and Crossman 1973). Some freshwater populations are migratory, moving among lakes, streams, and rivers; others are non-migratory or lake-dwelling populations. Freshwater populations could consist of dwarf forms existing sympatically with normal-size fish (Cohen 1954; Wohlschlag 1954; Mann 1974; Mann and McCart 1981).

During summer and fall, least cisco are common in nearly all habitats of the coastal North Slope. They are distributed throughout the freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002); they occur in the river channels, outer channels, tapped lakes, and perched lakes of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b, 1999a, 1999b); and they are one of the most abundant species found in Beaufort Sea coastal waters (Craig and Haldorson 1981, Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Philo et al. 1993b; Griffiths et al. 1996). Adults from Colville

---

[2] Fish of the genus *Salvelinus* along the Beaufort Sea Coast and on the North Slope before the mid-1980s were identified as the Bering Seawestern Arctic form of the Arctic char (*S. alpinus*) (after McPhail 1961). These “char” (anadromous, residual, and isolated stream resident forms) from the continental slope west of the Mackenzie River are in fact Dolly Varden; lake-dwelling forms from this area are relict Arctic char (Reist et al. 1997; Morrow 1980a; Behnke 1980, 1984).

River stocks regularly disperse as far east as Brownlow Point, some 180 km away (Fechhelm et al. 2000; Griffiths et al. 2002a). Within the Colville River Delta, lakes are occupied by normal, large, and stunted forms with no obvious geographical separation among them (Moulton 1999a).

Least cisco spawn in late September and October (Morrow 1980b). Fall spawning runs, most likely of amphidromous forms, occur in the Colville, Ikpikpuk, and Price rivers (Bendock and Burr 1984b). Spawning of non-migratory forms takes place in lakes. Eggs are deposited in sand or gravel along river and lake shores (Scott and Crossman 1973). Eggs remain on the bottom over winter and hatch the following spring.

The Colville River Delta is a very important least cisco overwintering habitat. Least cisco prefer lower salinities than do Arctic cisco, which prefer more brackish conditions. Thus the least cisco typically overwinters in the upper reaches of the Delta, whereas the Arctic cisco overwinters along or near the coast.

BROAD WHITEFISH (AANAAKLIQ)

During summer and early fall, broad whitefish, like least cisco, are common in virtually all habitats of the coastal North Slope. They are distributed throughout the freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002); they occur in the river channels, outer channels, tapped lakes, and perched lakes of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b); and they are one of the most abundant species found in Beaufort Sea coastal waters (Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1996). Juveniles appear to be intolerant of high salinities and typically remain close to river deltas (Fechhelm et al. 1992). Adults undergo more extensive coastal migrations (Morris 2000). Significant portions of the broad whitefish populations along the northern coast appear to move to and from spawning/wintering areas and summer rearing areas via nearshore habitats and to rely more on productive stream and lake habitats for summer feeding.

Upstream spawning runs begin as early as June and could last into September (Morrow 1980b). Spawning occurs from September into November, however, most spawning is complete by mid-October. Fish in spawning condition and actual spawning events have been observed in the late summer and early fall in the Colville River near Ocean Point, at the mouth of the Anaktuvuk River (McElderry and Craig 1981), near Umiat (Alt and Kogl 1973; Bendock 1979b), in the Nigliq Channel (Kogl and Schell 1974), and in the Ikpikpuk River (Bendock and Burr 1984b). Following spawning, which takes place over gravel bottoms, adults disperse throughout the watershed to overwinter (Morrow 1980b). Young hatch the following spring and disperse downriver. Rearing is in isolated backwaters, oxbows, and other low-velocity areas throughout the middle and lower river (Moulton and Carpenter 1986, citing T. Bendock ADF&G, pers. comm.). The network of small streams is particularly valuable as rearing habitat, and these streams also serve as migratory corridors among habitats. Overwintering could occur anywhere in the Colville and National Petroleum Reserve-Alaska watersheds provided there is sufficient water depth. McElderry and Craig (1981) reported broad whitefish of all sizes in many of the lakes and main channels of the Colville River Delta as far inland as the mouth of the Anaktuvuk River during September.

Congregations of broad whitefish begin to arrive at spawning areas several weeks to more than a month before spawning. Because Beaufort broad whitefish tend to winter at spawning areas, they will persist in high concentrations after spawning until break-up dispersal occurs. Broad whitefish tend not to disperse from spawning grounds unless water quality changes necessitate movement (Morris 2000, 2003). Spawning likely takes place predominantly in September and into October in the mid-Beaufort populations. The Ublutuoch River is used extensively by broad whitefish during all seasons and provides significant wintering habitat for this species.

HUMPBACK WHITEFISH (PIQUKTUUQ)

North Slope populations of humpback whitefish are centered around the Colville River and occur in many rivers farther to the west. They spawn in the Delta and in the middle and upper (upstream from Umiat) reaches of the Colville River during September and October (Alt and Kogl 1973; Kogl and Schell 1975; Bendock 1979b). Fish in spawning condition also have been reported in the upper Ikpikpuk drainage in September (Bendock and Burr 1984a). Spawning occurs in moderately swift running water over gravel bottoms in lakes, streams, and rivers (Alt 1979). The average life span for Colville River fish is probably to the mid- to upper 20s, and a fish estimated to have been 37 years old has been reported (Burns 1990).

Excluding upriver spawning runs, the summer distribution of humpback whitefish within the Colville River and the National Petroleum Reserve-Alaska appears limited to main river channels, deltas, and low-salinity coastal areas. Bendock and Burr (1984b) reported that although humpback whitefish were distributed throughout the Ikpikpuk River drainage and the lower reaches of Fish Creek and the Kalikpik River, they occur in only two (3 percent) of the lakes sampled. Philo et al. (1993a) reported taking only 18 humpback whitefish (0.1 percent of total catch) during a 3-year survey of Teshekpuk Lake just northwest of the Plan Area. Excluding a large July run of adult humpback whitefish in the Ublutuoch River and some fish taken in a tapped lake off Judy Creek in June, few fish were collected in Fish and Judy creeks or in nearby perched lakes during the summer (MJM Research 2002; Moulton 2002). Humpback whitefish were frequently found in river channels and tapped lakes of the Colville River Delta, but were scarce in perched lakes (Moulton 1996a, 1996b). Humpback whitefish are very abundant in the outer Colville River Delta (Fawcett et al. 1986), and adults regularly disperse eastward to Prudhoe Bay (Fechhelm 1999). Juveniles appear to remain close to the lower Delta, presumably because of their intolerance for saline waters (Fawcett et al. 1986; Burns 1990).

The apparent intolerance to high salinities during summer is somewhat inconsistent with overwintering preference. There is evidence that humpback whitefish overwinter in the lower Colville River Delta, where salinities are high (Burns 1990). Morrow (1980b) considered the species to be “truly anadromous.” If so, only the very lower reaches of the Colville River Delta would offer viable overwintering habitat.

FRESHWATER SPECIES

ARCTIC GRAYLING (SULUKPAUGAQ)

Grayling are one of the most widespread and abundant species in the Colville River drainage above the confluence of the East and West Delta channels (Kogl 1971; Bendock 1979b). They occur in the main Colville River channel near Umiat, in major tributaries (Itkillik, Anaktuvuk, Chandler, Killik rivers), in smaller rivers and streams (Awuna, Kiligwa, Kuna, Kurupa, Ipanavik, and Nuka rivers; Aupuk and Ikagiak creeks), and in many of the Alpine lakes (such as Shainin, Sitchiak, Ahaliorak, Chandler, Betty, and Etivlik lakes) (Kogl 1971; Furniss 1974; Bendock 1979b). Grayling spawn in most of these upstream habitats and exhibit no particular preference for substrate (Bendock 1979b; Morrow 1980b). Bendock (1979b) observed that spawning in the main Colville River channels was heaviest upstream from the confluence of the Etivluk River. Downstream, primary spawning habitat was more limited to side tributaries and larger stream channels.

Grayling are far less common in the channels, lakes, and streams of the lower Colville River Delta (Moulton 1996a, 1996b, 1999a) and in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Reasearch 2001, 2002; Moulton 2000, 2002). Concentrations of adult and subadult Arctic grayling use the Ublutuoch River extensively during summer and for overwintering. Arctic grayling in Fish and Judy creeks are most strongly associated with tundra drainages and tundra drainage outfalls in the main channels. Although widely distributed, their occurrence is sporadic, particularly in the perched and tapped lakes of the Delta (Moulton 1996a, 1996b, 1999a).

BURBOT (TITAALIQ)

Burbot are distributed throughout the Colville River watershed and the coastal lakes and streams of the National Petroleum Reserve-Alaska but are typically taken in small numbers (Furniss 1974; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a). They have been taken in Anaktuvuk, Chandler, and lower Killik rivers and in the Colville River near the mouth of the Killik River (Bendock 1979b). Bendock and Burr (1984b) noted that burbot are not easily captured by gill nets and that early surveys could have underestimated their distribution within North Slope drainages. Fyke net surveys conducted in the channels and lakes of the Colville River Delta reported small sporadic catches (Moulton 1996a, 1996b). Burbot spawn in the Colville River near Umiat in late winter. Rearing areas include the mouths of minor tributaries of the lower Colville River Delta (Bendock 1979b). Burbot also appear to spawn in the lower reaches of the Ublutuoch River within the Plan Area and move extensively throughout main channel habitats and small tundra drainages during the open-water season although numbers of burbot in the Fish Creek drainage are low (Morris 2003).

LAKE TROUT (IQALUAQPAK), ROUND WHITEFISH (SAVIGUNNAQ), ALASKA BLACKFISH (ILUUGINIQ), NINESPINE STICKLEBACK (KAKALISAURAQ), SLIMY SCULPIN (KANAYUQ), NORTHERN PIKE (SIULIK), AND LONGNOSE SUCKER (MILUGIAQ)

Summary information on these species is in Table 3.3.2-2.

MARINE SPECIES

FOURHORN SCULPIN (KANAYUQ), ARCTIC FLOUNDER (NATAAGNAQ OR PUYYAGIAQ), ARCTIC COD (IQALUGAQ), AND SAFFRON COD (UUGAQ)

Summary information on these species is in Table 3.3.2-2.

3.3.2.5 Fisheries

Commercial and subsistence fisheries operate in the Colville River Delta. Catch and effort records have been maintained for the commercial fishery since 1967 (Gallaway et al. 1983, 1989). Additional, early research describing the fisheries can be found in George and Nageak (1986), Moulton et al. (1986b), Nelson et al. (1987), and Craig (1989b). More recently, fishery data have been collected as part of Prudhoe Bay and other monitoring studies (Moulton et al. 1990, 1992, 1993; Moulton and Field 1988, 1991, 1994; Moulton 1994, 1995, 1997, 2001, 2002).

COMMERCIAL FISHERIES

The Helmericks family operates an under-ice commercial fishery in the Colville River Delta during fall (Gallaway et al. 1983, 1989). Harvest records have been rigorously maintained since 1967 and provide a detailed history of annual harvest over the past 35 years. Fishing typically begins in early October and continues through the end of November. It is conducted in the main (Kupigruak) and east channels of the river near Anachlik Island (Gallaway et al. 1983, 1989). The three principal species targeted in the fishery are Arctic cisco, least cisco, and humpback whitefish.

Arctic cisco is the dominant species taken in the fishery, with gill net catches consisting largely of fish ranging in age from 5 to 8 years (Moulton 2003). The total annual harvest averages 17,927 fish, but catch varies considerably among years. Catch-per-unit-effort (fish/day/46 meters of net) from 1967 to 2000 ranged from a high of 196 fish/day in 1986 to a low of 12.2 fish/day in 1980 (Figure 3.3.2.5-1). These fluctuations are largely due to variable recruitment of young fish from spawning grounds in Canada's Mackenzie River system (see species accounts in Section 3.3.2.4 and Table 3.3.2-2). Strongly recruited year classes enhance yields; poorly recruited year classes result in weaker harvests. Physical conditions within the Delta also affect annual harvest. Arctic cisco prefer brackish water, and when conditions become too fresh they move out of traditional fishing areas. Yields regularly exhibit a positive correlation with salinity (Moulton et al. 1990, 1992; Moulton and Field 1994).

The last peak in the catch rate of Arctic cisco in the Colville River Delta fishery occurred in 1996 and was the third highest observed for the period of record (Figure 3.3.2.5-1). There was a marked decline in Arctic cisco abundance between 1996 and 2002 (Moulton 2003). The catch rates during 2001–2002 are reported to have been among the lowest on record. The lack of saline water intrusion up the Colville River main channel could be a contributing factor to the observed declines. Thus, abundance of Arctic cisco in the fishery has exhibited a near-continuous decline over the past 6 years. This decline is not unprecedented. Similar declines were seen between 1973 and 1980 (this period was followed by a peak year in abundance in 1981) and between 1986 and 1991 (a period again followed by increased catch rates in 1992 and a peak in 1993) (Gallaway et al. 1983, 1989; Moulton 2001). On the basis of abundance of near-commercial-size Arctic cisco in the coastal zone during summer 2002 and 2003, it appears that a rebound in the fishery should be seen in the 2003 fall fishing season (Fechhelm et al. 2003; Fechhelm 2003).

The harvest of least cisco also fluctuates among years, partially in response to natural oscillations in population. However, this species also responds to physical conditions on the Delta, preferring water less saline than does the congeneric Arctic cisco. When water becomes too saline, yields often decline (Moulton 2001b).

The harvest of humpback whitefish has changed dramatically over the 35-year period of record. Before 1981, annual catch rates were nominal at fewer than 5 fish/day/46 meters of net (Figure 3.3.2.5-1). Following a 5-year data gap from 1982 to 1986, the harvest increased to annual levels ranging from 4 to 44 fish/day/46 meters of net. The reasons for this dramatic change in annual harvest are unclear.

NUIQSUT SUBSISTENCE FISHERY

Information on the seasonal timing of the subsistence fishery can be found in Table 3.3.2-2.

The Inupiat community of Nuiqsut operates subsistence fisheries in the Colville River Delta year-round, although most fishing effort occurs in summer and fall. The summer fishing season generally begins in July and extends until early September when freeze-up ends the open-water period (Moulton et al. 1986b). Fishing is concentrated in the Nigliq Channel in the western Colville River Delta, in the main stem Colville River just upstream of Nuiqsut in the Tiragruag area, and in Fish Creek (Craig 1989b; George and Nageak 1986). The fishery targets broad whitefish, with the harvest ranging from approximately 3,000 to 4,000 fish (Moulton et al. 1986b; Nelson et al. 1987). Other species taken incidentally include Dolly Varden, humpback whitefish, pink salmon, and chum salmon.

The fall under-ice fishery, which is the major fishery of the year, begins in late September to early October and typically lasts through late November (Moulton 1997). The fishing effort is concentrated in the upper Nigliq Channel near Nuiqsut, the lower Nigliq Channel near Woods Camp, and the Nigliq Delta (Craig 1989b; Moulton 1999b). Over the past 15 years, the effort has shifted downstream, and 2000 was the first year in which fishing effort in the Delta was the highest of the three areas (Moulton 2001). Arctic cisco is the principal species targeted, accounting for nearly 70 percent of the total annual harvest. Other targeted species include least cisco, broad whitefish, and humpback whitefish. The estimated mean annual harvest from 1985 to 2000 was 21,241 Arctic cisco, 7,011 least cisco, 1,860 humpback whitefish, and 667 broad whitefish. Species taken incidentally include Bering cisco, Arctic grayling, rainbow smelt, round whitefish, Dolly Varden, burbot, Arctic flounder, and fourhorn sculpin.

The harvests of Arctic cisco and least cisco fluctuate among years for the same reasons described above for the commercial fishery.

Additional information on the subsistence fishery can be found in Section 3.4.3 (Subsistence Harvest and Uses).

3.3.3 Birds

Approximately 80 bird species are likely to occur in the Plan Area and in nearshore waters of the Beaufort Sea (BLM and MMS 1998a). Table 3.3.3-1 lists the common, scientific, and Inupiaq names of these species. Most birds in the Plan Area are migratory and arrive in May and June. Some species begin to migrate to wintering or molting grounds as early as July, and for individuals of a few species, fall migration could extend into November (Table 3.3.3-2). The following description of the birds of the Plan Area concerns primarily the common and regularly occurring species, although uncommon species are also mentioned as they are considered sensitive or of special concern to regulatory agencies. The predominant groups in terms of number of species and individuals are waterfowl (tinmiagruich) and shorebirds, although the single most numerous species is the passerine, Lapland longspur (See Table 3.3.3-3) (Derksen et al. 1981; Johnson et al. 2003a; Burgess et al. 2003a). Also represented in the Plan Area are loons (malgitch), seabirds, and raptors. These species and their habitats have been described in detail in recent EISs, environmental assessments, and planning documents, including the Liberty Development and Production Plan (MMS Alaska OCS Region 2002b); the Beaufort Sea Oil and Gas Development/Northstar Project (USACE Alaska District 1999); the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a); the Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a); the Colville River Unit Satellite Development Environmental Evaluation Document (PAI 2002a); and the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003). This discussion incorporates, by reference, these descriptions and augments them with information from historical and ongoing research pertinent to this review.

Results of aerial surveys flown during different nesting stages may not always show the same population trends. The USFWS’s aerial breeding pair surveys during late June through early July are presented here to set the context for general patterns of distribution for most waterbirds across the Arctic Coastal Plain (Mallek et al. 2003). The USFWS’s mid-June surveys designed to detect pre-nesting male eiders before they leave the Arctic Coastal Plain in late June to early July are presented for king eiders, spectacled eiders, and Steller’s eiders (Larned et al. 2003). Population trends presented are based on 1986 to 2002 breeding pair surveys for all waterfowl and loons, except eiders (Mallek et al. 2003). Population sizes and trends for eiders, seabirds, owls, and common ravens are based on 1992 to 2003 eider survey results (Larned et al. 2003b). The USFWS’s breeding pair survey and eider survey results are presented to describe bird distributions across the Arctic Coastal Plain and to evaluate effects of hypothetical field development in Section 4. Site-specific aerial and ground-based survey results are presented to describe bird densities and distributions in the areas next to the five CPAI proposed pad locations and to evaluate potential effects of the proposed development alternatives in Section 4.

TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA

Common Name	Scientific Name[a]	Inupiaq Name[b]	Status[c]	Occurrence[d]
Waterfowl (Tinmiagruich) and Waterbirds				
Greater white-fronted goose	*Anser albifrons*	niglik	--	C/B
Snow goose	*Chen caerulescens*	kanuq	--	U/B, C/M
Canada goose	*Branta canadensis*	iqsragutilik	--	C/B
Brant	*Branta bernicla*	niglingaq	SS	C/B
Tundra swan	*Cygnus columbianus*	kugruk	--	C/B
Gadwall	*Anas strepera*	--	--	Acc
American wigeon	*Anas americana*		--	U/B
Mallard	*Anas platyrhynchos*	kurugaktak	--	R/B
Northern shoveler	*Anas clypeata*	alluutaq	--	R/B
Northern pintail	*Anas acuta*	kurugak	--	C/B
Green-winged teal	*Anas crecca*	qaiffiq	--	U/B
Canvasback	*Aythya valisineria*		--	Acc
Greater scaup	*Aythya marila*	qaqluktuuq	--	U/B
Lesser scaup	*Aythya affinis*	kaklutuk	--	R/B
Steller's eider	*Polysticta stelleri*	igniqauqtu	T	R/B
Spectacled eider	*Somateria fischeri*	kavaasuk	T	U/B
King eider	*Somateria spectabilis*	qinalik	SS	C/B
Common eider	*Somateria mollissima*	amauligruaq	--	C/B
Surf scoter	*Melanitta perspicillata*	aviluktuq	SS	U/B
White-winged scoter	*Melanitta fusca*	killalik	--	U/B
Black scoter	*Melanitta nigra*	tuungaagrupiaq	SS	Acc
Long-tailed duck	*Clangula hyemalis*	ahaaliq	SS	C/B
Red-breasted merganser	*Mergus serrator*	aqpaqsruayuuq	--	R/B
Loons (Malgitch) and Grebes				
Red-throated loon	*Gavia stellata*	qaqsraupiagruk	SS	C/B
Pacific loon	*Gavia pacifica*	qaqsrauq	--	C/B
Yellow-billed loon	*Gavia adamsii*	tuullik	BCC, SS	U/B
Red-necked grebe	*Podiceps grisegena*	aqpaqsruayuuq	--	U/B
Horned grebe	*Podiceps auritus*	subliq	--	Acc
Ptarmigan				
Willow ptarmigan	*Lagopus lagopus*	nasaullik	--	C/B
Rock ptarmigan	*Lagopus mutus*	niksaaktun	--	U/B
Cranes				
Sandhill crane	*Grus canadensis*	tatirgak	--	U/B
Raptors and Owls				
Bald eagle	*Haliaeetus leucocephalus*	tinmiaqpak	--	R
Northern harrier	*Circus cyaneus*	papiktuuq	--	U/B

TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA (CONT'D)

Common Name	Scientific Name[a]	Inupiaq Name[b]	Status[c]	Occurrence[d]
Raptors and Owls				
Rough-legged hawk	*Buteo lagopus*	qixbiq	--	U/B
Golden eagle	*Aquila chrysaetos*	tingmiak	--	U/B
Merlin	*Falco columbarius*	tinmiabruum kirbavia	--	R
Gyrfalcon	*Falco rusticolus*	aatqarruaq	--	U/B
Peregrine falcon	*Falco peregrinus*	kirgavik	BCC, SS	B/M
Snowy owl	*Bubo scandiacus*	ukpik	--	C/B
Short-eared owl	*Asio flammeus*	nipailuktaq	--	C/B
Shorebirds				
Black-bellied plover	*Pluvialis squatarola*	tullikpak	--	C/B
American golden-plover	*Pluvialis dominica*	tullik	BCC	C/B
Semipalmated plover	*Charadrius semipalmatus*	kurraquraq	--	U/B
Whimbrel	*Numenius phaeopus*	sigguktuvak	BCC	U/B
Bar-tailed godwit	*Limosa lapponica*	turraaturaq	BCC	U/B
Red knot	*Calidris canutus*		SS	R
Ruddy turnstone	*Arenaria interpres*	tullignaq	--	C/B
Black turnstone	*Arenaria melanocephala*	--	BCC	Acc
Sanderling	*Calidris alba*	kimitquilaq	--	R/B
Semipalmated sandpiper	*Calidris pusilla*	livalivakpauruk	--	C/B
Western sandpiper	*Calidris mauri*	--	--	R/B
Least sandpiper	*Calidris minutilla*	livalivaurak	--	R/B
White-rumped sandpiper	*Calidris fuscicollis*	--	--	R/B
Baird's sandpiper	*Calidris bairdii*	puviaqtuuyaaq	--	U/B
Pectoral sandpiper	*Calidris melanotos*	puviaqtuuq	--	C/B
Dunlin	*Calidris alpina*	kayuttavak	BCC	C/B
Stilt sandpiper	*Calidris himantopus*	--	--	C/B
Buff-breasted sandpiper	*Tryngites subruficollis*	puviaqtuuq	BCC, SS	U/B
Long-billed dowitcher	*Limnodromus scolopaceus*	kilyaktalik	--	C/B
Wilson's snipe	*Gallinago delicata*	--	--	U/B
Red-necked phalarope	*Phalaropus lobatus*	qayyiuun	--	C/B
Red phalarope	*Phalaropus fulicarius*	auksruaq	--	C/B
Seabirds				
Pomarine jaeger	*Stercorarius pomarinus*	isunngluk	--	U/B; C/M

TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA (CONT'D)

Common Name	Scientific Name[a]	Inupiaq Name[b]	Status[c]	Occurrence[d]
Parasitic jaeger	*Stercorarius parasiticus*	migiaqsaayuk	--	C/B
Long-tailed jaeger	*Stercorarius longicaudus*	isunnaq	--	C/B
Herring gull	*Larus argentatus*	nauyavvaaq	--	R/S
Thayer's gull	*Larus thayeri*	--	--	R/M
Glaucous-winged gull	*Larus glaucescens*	--	--	Acc
Glaucous gull	*Larus hyperboreus*	nauyak	--	C/B
Sabine's gull	*Xema sabini*	iqirgagiaq	--	U/B
Black-legged kittiwake	*Rissa tridactyla*	--	--	R/S
Arctic tern	*Sterna paradisaea*	mitqutailaq	BCC	C/B
Black guillemot	*Cepphus grylle*	--	SS	U/B
Passerines				
Common raven	*Corvus corax*	tulugaq	--	C/B
Arctic warbler	*Phylloscopus borealis*	sonakpalutuniq	BCC	R
Bluethroat	*Luscinia svecica*	--	--	R
Yellow wagtail	*Motacilla flava*	iksriktaayuuq	--	U/B
American tree sparrow	*Spizella arborea*	misapsaq	--	U/B
Savannah sparrow	*Passerculus sandwichensis*	okpisioyuk	--	C/B
Lapland longspur	*Calcarius lapponicus*	qupaluk, putukiiluk	--	C/B
Snow bunting	*Plectrophenax nivalis*	amautlgaq	--	U/B
Common redpoll	*Carduelis flammea*	saksakiq	--	C/B
Hoary redpoll	*Carduelis hornemanni*	saksakiq	--	U

Notes:

[a] Scientific names from List of the 2,031 Bird Species (with Scientific and English Names) Known from the A.O.U. Check-list Area (http://www.aou.org/aou/birdlist.html). The list incorporates changes made in the 42nd, 43rd, and 44th supplements to the check-list, as published in *The AUK* 117:847-858 (2000); 119:897-906 (2002); 120:923-932 (2003). Subspecies designations are presented where relevant.

[b] Inupiaq names as presented in PAI (2002a), Appendix B, Table B-3 and in Birds of Central Beringia, a taxonomic List in English, Russian, Inupiaq, Siberian Yupik, and Latin (http:/www.nps.gov/akso/beringia/berinotesnov97.htm).

[c] Federal status under the Endangered Species Act of 1973; USFWS Status Region 7 (Alaska Region) (USFWS 2002); and BLMSensitive Species status (Appendix E).

[d] Occurrence information from C.B. Johnson, pers. comm. (2003); Johnson and Herter (1989), Armstrong (1995), and USFWS (1999a).

Acc = Accidental
BCC = USFWS Birds of Conservation Concern
E = Endangered
R = Rare
SS = BLM Sensitive species
U = Uncommon

B = Breeding bird
C = Common
M = Migration
S = Summer
T = USFWS Threatened
W = Winter

TABLE 3.3.3-2 APPROXIMATE CHRONOLOGY OF ACTIVITIES FOR SELECTED BIRDS NESTING IN THE PLAN AREA

Species or Groups	Arrival in Nesting Area	Egg Laying	Hatch	Brood Rearing	Adult Molt	Fall Migration
Greater white-fronted goose	mid May–early June	late May–mid June	late June–early July	late June–late Aug.	mid July–early Aug.[a]	mid Aug.– mid Sept.
Brant	late May–early June	early June–late June	late June–mid July	late June–early Sept.	mid July–mid Aug.[b]	mid Aug.– mid Sept.
Tundra swan	mid May–late May	late May–early June	late June–mid July	late June–mid Sept.	mid July–Aug.	late Sept.–early Oct.
Loons	late May–early June	mid June–late June	mid July–late July	mid July–early Sept.	Winter	late Aug.–Sept.
Northern pintail males	late May	mid June–late June	early July–late July	early July–early Sept.	mid July–early Aug.	early Aug.–mid Sept.[c]
Long–tailed duck	late May	late June–early July	mid July–late July	mid July–early Sept.	late July–early Sept.[d]	late Sept.–Oct.
Black-bellied plover	late May–early June	early June–late June	mid July	mid July–Aug.	Not applicable	Aug.–mid Sept.
Semipalmated sandpiper	late May–early June	early June–-late June	late June–mid July	late June–July	Not applicable	late July–mid Aug.

Source: BLM and MMS 1998a

Notes:

[a] Nonbreeding young of the previous year and failed because breeders molt late June–late August.

[b] Nonbreeding, failed breeder molt–migrant brant: late June–early August.

[c] Male pintails depart early July–early August.

[d] Includes males, nonbreeders, failed breeders, as well as females with broods.

TABLE 3.3.3-3 OCCURRENCE AND ESTIMATED POPULATION NUMBERS OF SELECTED BIRD SPECIES FOR THE ARCTIC COASTAL PLAIN AND THE PLAN AREA

Common Name	Occurrence	Population Numbers[a]		
		Estimated Coastal Plain Population (mean)[b, c]	Estimated NE NPR-A Populations[d]	Estimated 2002 Plan Area Populations[e]
Waterfowl				
Greater white-fronted goose	mid May-mid Sept.	124,579	16,740	4,315
Molting		-	7,024	-
Snow goose		2,557	-	-
Canada goose	early June-late July	19,349	13,001	171
Brant	late May-early Sept.	9,720	-	655
Molting	late June-early Aug.	-	17,570	-
Tundra swan	mid May-early Oct.	9,998	1,821	319
Northern pintail	late May-mid Sept.	229,611	49,564	2,484
Scaup	late May-mid Sept.	33,422	8,864	49
King eider	late May- Oct.	12,881	8,418	1,170
Common eider[f]	late May- Oct.	2,580	0	0
Long-tailed duck	late May- Oct.	111,768	22,056	1,905
Scoters	late May-early Sept.	11,210	1,357	-
Loons				
Red-throated loon	early June-late Sept.	3,072	533	440
Pacific loon	late May-late Sept.	27,657	6,309	2,022
Yellow-billed loon	mid May-mid Sept.	2,957	898	296
Seabirds				
Glaucous gull	early May-Nov.	11,720	2,882	586
Sabine’s gull	late May-early Sept.	6,413	1,819	377
Arctic tern	late May-early Sept.	10,036	5,608	1,227
Jaegers	late May-mid Sept.	3,983	1,357	560
Raptors and Owls				
Arctic peregrine falcon	mid April-mid Sept.	-	-	-
Gyrfalcon[d]	Resident	100	-	-
Rough-legged hawk[d]	late April-early Oct.	600-1,000	-	-
Short-eared owl		86	-	-
Snowy owl		851	-	-
Passerines				
Common raven	Resident	63	-	20

Notes:

- dash indicates no population estimate was available.

[a] Population numbers are minimal estimates, and annually variable with standard errors ranging from 5 percent to over 75 percent of the estimated population.

[b] Population estimates for all waterfowl and loons, except eiders, with visibility correction factors applied to duck species are long-term averages from 1986-2001 from Mallek et al. (2003). Population estimates for colonial nesting species, snow goose and brant, may not reflect true population size.

[c] Population estimates for eiders, seabirds, raptors and owls, and common raven are long-term averages from 1992-2003 from Larned et al. (2003b). Visibility correction factors not applied, averages are minimum population estimates used to track population trend.

[d] Population estimates as presented in BLM and MMS (1998a).

[e] Population estimates calculated from aerial or ground-based survey densities uncorrected for visibility within the Plan Area (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b).

[f] Population estimates based on aerial surveys during late June are averages from 1999-2002 (Dau and Anderson 2002).

3.3.3.1 Habitat

The following habitat characteristics are attractive to loons, geese, ducks, and shorebirds (Derksen et al. 1979, 1982; Weller et al. 1994 as presented in BLM and MMS 2003):

- Presence of large, deep lakes with persistent ice floes providing refuge from terrestrial predators
- Availability of shoreline with relatively low relief allowing predator detection
- Presence of extensive peat/mud zone for resting and presence of extensive meadows of high-quality sedges, grasses, and mosses for feeding
- Low predator populations
- Low levels of human disturbance
- Proximity to coastal staging areas

NORTH SLOPE

Bergman et al. (1977) and later Derksen et al. (1981) used a wetland classification system to describe habitats used by birds in the National Petroleum Reserve-Alaska and the Prudhoe Bay area. This system focuses on waterbirds and was based on the characteristics of ponds and lakes in terms of water depth and presence or absence of the emergent sedge *Carex aquatilis* and the emergent grass *Arctophila fulva*. Eight habitat types were described: (I) flooded tundra, (II) shallow ponds with emergent *Carex*, (III) shallow ponds with emergent *Arctophila*, (IV) deep lakes with emergent *Arctophila*, (V) deep lakes without emergent *Arctophila*, (VI) basin complex (large, partially drained lake basins that could be flooded during spring melt), (VII) beaded streams, and (VIII) coastal aquatic habitats in low areas that border the Beaufort Sea (Bergman et al. 1977). Deep open lakes provide invertebrate and fish prey for diving ducks and loons. Coastal wetlands are used by staging shorebirds; brood-rearing, molting and staging waterfowl; and passerines. The Colville River corridor contains tall shrub stands used for nesting by some passerines. Riverbanks provide nesting habitat on bluffs adjacent to foraging habitats for raptors. Dry tundra is preferred by some shorebird species for nesting (BLM and MMS 2003).

PLAN AREA

Habitat selection preferences for nesting birds in the Plan Area have been determined by relating the percent use for each available habitat type to the percent available (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b). Habitat selection analyses were conducted for nesting sites and brood-rearing areas using data collected during ground searches or during aerial surveys in both the Colville River Delta and in the National Petroleum Reserve-Alaska portion of the Plan Area. Table 3.3.3-4 summarizes available habitats. In general, the Colville River Delta sites contain brackish, tapped lake, and riverine habitats absent from the National Petroleum Reserve-Alaska sites, while the National Petroleum Reserve-Alaska sites contain tussock tundra, which is rare in the Colville River Delta (Table 3.3.3-4). Nest densities recorded for all species located during large waterbird ground searches in the Colville River Delta were more than double the nest densities in the National Petroleum Reserve-Alaska sites with the exception of CD-5 (and therefore the total National Petroleum Reserve- Alaska) (Table 3.3.3-5). CD-5 is the site closest to the Colville River Delta of the four National Petroleum Reserve-Alaska sites (Figure 2.3.3.1-1 and Table 3.3.3-4). Habitat use and selection in the Plan Area are summarized in Table 3.3.3-6 and discussed in the following species accounts.

TABLE 3.3.3-4 HABITAT DISTRIBUTIONS FOR GROUND-BASED NEST SEARCH AREAS AND AERIAL SURVEYS IN THE PLAN AREA

Habitat	Colville River Delta Sites				National Petroleum Reserve-Alaska Sites[a]				
	Alpine[b](%)	CD-3[c](%)	CD-4[d](%)	Colville[d] Delta	CD-5(%)	CD-6(%)	CD-7(%)	Clover(%)	NPR-A Total(%)
Open Nearshore Water	0	3.4	0	1.8	0	0	0	0	0.5
Brackish Water	0	1.9	0	1.2	0	0	0	0	0.2
Tapped Lake with Low-water Connection	2.6	8.6	1.0	3.9	0	0	0	0	0.2
Tapped Lake with High-water Connection	7.6	2.8	8.7	3.8	0	0	0	0	<0.1
Salt Marsh	5.8	3.8	1.0	3.0	0	0	0	0	0.5
Tidal Flat	0	6.3	0	10.2	0	0	0	0	1.2
Salt-killed Tundra	0	7.3	0	4.7	0	0	0	0	<0.1
Deep Open Water without Islands	8.5	4.9	6.4	3.8	0.3	3.2	15.5	0	7.2
Deep Open Water with Islands or Polygonized Margins	0.9	2.0	1.6	1.4	5.8	0	5.8	0	5.2
Shallow Open Water without Islands	<0.1	0.4	0.3	0.4	0.2	0.2	1.0	0	1.0
Shallow Open Water with Islands or Polygonized Margins	0.1	0.1	0.1	0.1	8.2	1.2	4.6	0	1.6
River or Stream	<0.1	7.1	10.7	14.9	0	0	0.1	0	0.9
Aquatic Sedge Marsh	0.8	0	0.1	<0.1	1.6	0.9	15.8	0	1.7
Aquatic Sedge with Deep Polygons	1.1	4.1	1.1	2.4	0	0	0	0	<0.1
Aquatic Grass Marsh	1.0	0.2	0.6	0.3	0	0	0.9	0	0.3
Young Basin Wetland Complex	0	0	<0.1	<0.1	0	0	1.6	0	0.4
Old Basin Wetland Complex	0	0	<0.1	<0.1	16.2	4.5	5.9	0	8.8
Riverine Complex	0	0	0	0	0	3.8	0	0	0.4
Dune Complex	0	0	0	0	0	0	0	0	1.1
Nonpatterned Wet Meadow	9.0	10.5	6.4	7.5	1.7	0.1	19.3	0.8	3.1
Patterned Wet Meadow	41.2	20.2	30.5	18.6	32.1	6.6	2.6	7.3	11.3
Moist Sedge-Shrub Meadow	10.9	2.1	5.3	2.4	16.2	23.5	20.9	52.6	23.2
Moist Tussock Tundra	0	0.8	0.6	0.5	17.8	55.7	5.5	39.3	27.4
Riverine or Upland Shrub	5.9	2.6	11.7	5.0	0	0.3	0.4	0	2.7
Barrens (riverine, eolian, or lacustrine)	1.7	10.8	14.0	14.3	0	0	0	0	1.0
Artificial (water, fill, peat road)	2.9	0.1	0.1	<0.1	0	0	0	0	0
Nest Densities									
Nest Density (nests/km^2)	7.9	18.4	10.2	12.2	18.1	4.0	6.1	0.0	9.0

Notes: [a] Burgess et al. 2003b [b] Johnson et al. 2003a [c] Johnson et al. 2003b [d] Burgess et al. 2003a

Table 3.3.3-5 Ground-based Nest Densities (Nest/km^2) in the Plan Area

		CD North	CD South	Alpine West	Lookout	Spark	
Species[a]	**Alpine (6-year mean)[b]**	**CD-3 (4-year mean)[c]**	**CD-4 (3-year mean)[b]**	**CD-5 (2-year mean)[c]**	**CD-6 (2-year mean)[c]**	**CD-7 (2-year mean)[c]**	**NPR-A Area (2003)[d]**
Waterfowl and Waterbirds							
White-fronted goose	3.4	11.4	4.6	9.5	3.0	1.0	5.8
Snow goose	0	0.1	0	0	0	0	0
Canada goose	0.1	0.1	0	3.5	0.1	0	1.4
Brant	0.2	1.4	0	1.8	0	0	0.6
Tundra swan	0.4	0.3	0.3	0.2	0	0	<0.1
Mallard	0	0	<0.1	0	0	0	0
Northern shoveler	0.1	<0.1	0.1	0.2	0	0	0
Northern pintail	0.5	0.2	1.3	0.3	0.2	0.6	0.1
Green-winged teal	0.1	0	<0.1	0	0.2	0	<0.1
Greater scaup	0.1	0	<0.1	0	0	0	<0.1
Lesser scaup	<0.1	0	0	0	0	0	0
King eider	<0.1	0.1	0	0.5	0	0.6	0.7
Long-tailed duck	0.4	1.4	0.2	0.5	0.4	0.4	0.4
Loons and Grebes							
Red-throated loon	0.2	0.6	0.2	0.2	0.1	0	0.1
Pacific loon	0.5	0.9	0.4	1.9	0	1.2	0.9
Yellow-billed loon	0.1	0.3	0.1	0	0.1	0.2	0.1
Red-necked grebe	0.1	0	0.1	0	0	0	0
Grouse							
Willow ptarmigan	0.7	0.3	1.6	0.6	1.0	0	0.4
Rock ptarmigan	<0.1	0	0.1	0	0	0	0
Cranes and Large Shorebirds							
Sandhill crane	<0.1	0	0	0	0	0	0
Whimbrel	0	0	0.1	0	0	0	0
Bar-tailed godwit	0.1	0.1	0.1	0	0	0	0.2
Wilson’s snipe	<0.1	0	0	0	0	0	0

TABLE 3.3.3-5 GROUND-BASED NEST DENSITIES (NEST/KM^2) IN THE PLAN AREA (CONT'D)

		CD North	**CD South**	**Alpine West**	**Lookout**	**Spark**	
Species[a]	**Alpine (6-year mean)[b]**	**CD-3 (4-year mean)[c]**	**CD-4 (3-year mean)[c]**	**CD-5 (2-year mean)[c]**	**CD-6 (2-year mean)[c]**	**CD-7 (2-year mean)[c]**	**NPR-A (2003)[d]**
Raptors and Owls							
Northern harrier	0	0	<0.1	0	0	0	0
Short-eared owl	<0.1	0	0.1	0	0	0	0
Seabirds							
Parasitic jaeger	0.1	0.1	<0.1	0.1	0	0.2	0.2
Long-tailed jaeger	0.1	0	0.2	0.2	0	0	0.1
Glaucous gull	0.1	0.4	0.1	1.0	0	0.2	0.7
Sabine's gull	<0.1	0.4	0	0	0	0.6	0.2
Arctic tern	0.4	0.8	0.4	0.4	0.1	0.5	0.7

Notes:

[a] Nest densities for small shorebirds and passerines are presented in Table 3.3.3-7.

[b] Burgess et al. 2003a (Table 6)

[c] Means calculated from data presented in Burgess et al. (2003a), Burgess et al. (2003b), Johnson et al. (2003b) and Johnson et al. (2004).

[d] Johnson et al. 2004

TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a]

Habitat	Greater White-Fronted Goose[b]			Lesser Snow Goose		Canada Goose		Black Brant		Tundra Swans		Northern Pintail		Scaup	King Eiders		Long-Tailed Ducks		Red-Throated Loons		Pacific Loons		Yellow-Billed Loons		Glaucous Gulls		Sabine's Gull		Arctic Tern	
	Nesting	Brood-rearing	Staging	Brood-rearing	Staging	Brood-rearing	Staging	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Pre-nesting	Nesting	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing
Colville River Delta[c]																														
Open Nearshore Water	A				U					A	A																			
Brackish Water		U		U	U		U		P		P				P				U	U	P	U			U	U				
Tapped Lake with Low-water Connection	A	U	U			U				A	P												A			U				
Tapped Lake with High-water Connection	A					U				A	P										P	U		P	U					
Salt Marsh	A						U			P	P																			
Tidal Flat					U			A	A	A	A				A								A							
Salt-killed Tundra	A						U	P		P		U				U	A		U		A		A				U	U		
Deep Open Water without Islands	A	U		U							P		U		A		P	U				U		P				U		U
Deep Open Water with Islands or Polygonized Margins		U	U							P	P	U	U			U	P	U			P	U	P	P	U	U	U	U	U	U
Shallow Open Water without Islands																		U												
Shallow Open Water with Islands or Polygonized Margins																	P		U	U	P	U						U	U	U
River or Stream			U					A		A	A				P								A	A						
Aquatic Sedge with Deep Polygons	P							P		P		U	U	U		U	P	U	U	U	A		P		U	U	U		U	U

TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

Habitat	**Greater White-Fronted Goose[b]**			**Lesser Snow Goose**		**Canada Goose**		**Black Brant**		**Tundra Swans**		**Northern Pintail**		**Scaup**	**King Eiders**		**Long-Tailed Ducks**		**Red-Throated Loons**		**Pacific Loons**		**Yellow-Billed Loons**		**Glaucous Gulls**		**Sabine's Gull**		**Arctic Tern**	
	Nesting	Brood-rearing	Staging	Brood-rearing	Staging	Brood-rearing	Staging	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Pre-nesting	Nesting	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing
Aquatic Grass Marsh											P																			
Nonpatterned Wet Meadow				U								U		U	A						A			A			U	U	U	U
Patterned Wet Meadow	P	U					U			P		U		U	A	U			U		A		P	A			U	U	U	U
Colville River Delta[c]																														
Moist Sedge-Shrub Meadow	A				U					P		U											A							
Riverine or Upland Shrub	A									A	A	U			A								A				U			
Barrens (riverine, eolian, or lacustrine)	A						U			A	A				A								A	A						

TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

Habitat	Greater White-Footed Goose			Canad Goose		Black Brant		Tundra Swans		Northern Pintail		King elders		Long-Tailed Ducks		Red-throated Loons		Pacific Loons		Yellow-billed Loons		Glaucous Gulls		Sabine's Gull		Artic Tern	
	Nesting	Brood-rearing	Staging	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Pre-nesting	Nesting	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing
NPR-A Sites[d]																											
Brackish Water												P															
Tapped Lake with Low-water Connection									P																		
Deep Open Water without Islands	A	U	U					A	P			P			U				U		P						
Deep Open Water with Islands or Polygonized Margins	A	U	U				U		P			P						U	U	P	P	U		U			U
Shallow Open Water without Islands												P			U				U								
Shallow Open Water with Islands or Polygonized Margins	A	U		U		U		P				P	U	U		U	U	U	U			U	U	U	U	U	U
Aquatic Sedge Marsh	A									U		P	U	U	U			U	U	P				U	U	U	U
Aquatic Grass Marsh								P											U	P							
Riverine Complex							U								U											U	
Young Basin Wetland Complex						u																				U	
Old Basin Wetland complex	P	U	U	U					A	U			U	U		U	U			A						U	U
Nonpatterned Wet Meadow	A													U													

TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

Habitat	Greater White-Footed Goose			Canad Goose		Black Brant		Tundra Swans		Northern Pintail		King elders		Long-Tailed Ducks		Red-throated Loons		Pacific Loons		Yellow-billed Loons		Glaucous Gulls		Sabine's Gull		Artic Tern	
	Nesting	Brood-rearing	Staging	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Pre-nesting	Nesting	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing	Nesting	Brood-rearing
NPR-A Sites[d]																											
Patterned Wet Meadow	P		U					U	A	U	U	A	U							U							
Moist Sedge-Shrub Meadow	U		U		U				A			A		U						A	A			U			
Moist Tussock Tundra	P								A	U	U	A		U	U					A	A						
Riverine Low and Tall Shrub		U																									

Notes:

[a] Selection(A,P) is based on use in proportion to availability compared to random habitat selection. If no selection analysis was completed use information is presented. Use (U) is reported as occurrence for ≥10% of nests or broods within a habitat

[b] Johnson et al. 2003a, 2004

[c] Burgess et al. 2003a, Johnson et al 2004

[d] Burgess et al. 2003b, Johnson et al. 2004

3.3.3.2 Waterfowl (Tinmiagruich)

Numerous species of waterfowl, including 15 species of ducks, 4 species of geese, and 1 swan species, regularly occur across the Arctic Coastal Plain and in the Plan Area (Table 3.3.3-1 and Table 3.3.3-3). Species-specific surveys within the Plan Area have focused on tundra swan, black brant (*Branta bernicla nigricans*), spectacled eiders, Steller's eiders, and king eiders. Focus on these species has been based on their status as sensitive, federally listed as threatened, or of special concern of regulatory agencies and on the importance of the Plan Area as breeding, molting, brood-rearing, and/or staging habitat (Johnson et al. 1999). Spectacled and Steller's eiders are discussed in Section 3.3.5, Endangered and Threatened Species.

GEESE

NORTH SLOPE

Four goose species commonly nest on the North Slope. In order of decreasing abundance, these are greater white-fronted goose, Canada goose, brant, and snow goose (*Chen caerulescens*), (Table 3.3.3-3). Greater white-fronted goose is the most common and widespread of the four species, and their population increased at a rate of approximately 2 percent per year on the Arctic Coastal Plain during 1986 to 2002 (Mallek et al. 2003). Derksen et al. (1981) reported that greater white-fronted geese nested on upland sites or polygonal ground near shallow *Carex* [Aquatic Sedge Marsh] and *Arctophila* [Aquatic Grass Marsh] wetlands, while post-breeding birds used deep open lakes [Deep Open Water] during the molting period. Greater white-fronted geese concentrate on the Arctic Coastal Plain southeast of Point Lay, east of Wainwright, and northeast of Teshekpuk Lake (Figure 3.3.3.2-1).

The Canada goose is a common species that nests in low densities in the Prudhoe Bay area, the Colville River Delta, and the National Petroleum Reserve-Alaska. It is a much more common breeder in the interior of Alaska than on the Arctic Coastal Plain. After nesting, small flocks of interior-nesting Canada geese migrate to the Arctic Coastal Plain where they aggregate with locally nesting geese to molt (S. Johnson 2003, pers. comm.). The Arctic Coastal Plain population of Canada geese has varied from lows near 3,000 in 1989 and 1994 to highs near 47,000 in 1986 and 1999 (Mallek et al. 2003). The 2002 population estimate was 52 percent lower than the mean population size calculated from the surveys conducted from 1986 through 2001 (Mallek et al. 2003). Derksen et al. (1981) reported that Canada geese in the National Petroleum Reserve-Alaska fed in upland sites and in flooded tundra and shallow *Carex* [Aquatic Sedge Marsh] wetlands during June but moved to deep open lakes [Deep Open Water] that afforded more protection from predators during the July molt.

Brant nest in small and large colonies that are used year after year. These colonies generally are near the coast but could be 30 km or more inland (Derksen et al. 1981; BLM and MMS 1998a; Reed et al. 1998). Brant nest at many locations in the Prudhoe Bay area. The greatest nesting densities have been at two colonies, one in the Colville River Delta and the other in the Sagavanirktok River Delta (Sedinger and Stickney 2000). There are approximately 100 nesting pairs in the Kuparuk River Delta. The numbers of nests in parts of the Colville River Delta have increased dramatically in recent years, while the number of nests in the Sagavanirktok River Delta have declined (Sedinger and Stickney 2000). Due to the clumped distribution of colonial nesting species such as brant and snow geese, population estimates from standard aerial breeding pair surveys may not reflect the true population size and distribution (Mallek et al. 2003). Brant often build nests on small islands in ponds or river deltas and on offshore islands. Broods are reared on nearby tidal flats and salt marshes and at inland lakes. Brant use deep *Arctophila* lakes for nesting and could move broods to deep open lakes for brood-rearing (Bergman et al. 1977; Derksen et al. 1981), although most brood-rearing takes place in coastal areas. Large numbers of molting and brood-rearing brant use lakes located north and east of Teshekpuk Lake in the National Petroleum Reserve-Alaska (Derksen et al. 1982).

Snow geese nest primarily in arctic Canada and Russia, although a few small colonies nest on Alaska's Arctic Coastal Plain. The population of snow geese on the Coastal Plain has increased dramatically in recent years (Ritchie et al. 2000) and recently, the Ikpikpuk colony has been the largest on the Arctic Coastal Plain. The colony on Howe Island in the Sagavanirktok River Delta, adjacent to the active Endicott oil production field, declined in the late 1990s, apparently as a result of terrestrial predators (foxes and bears) (Johnson 2000a). A few other small and medium-sized colonies are scattered across the Beaufort Sea Coast. Because of the colonial nesting tendency of snow geese, breeding pair surveys might not reflect the true population size and distribution (Mallek et al. 2003).

PLAN AREA

Greater white-fronted geese nested at all proposed development areas except the Clover Potential Gravel Source (Table 3.3.3-5). Highest nesting densities for this species were at the Colville River Delta sites (Figure 3.3.3.2-2) and at CD-5 in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-3 and Table 3.3.3-5). Nesting greater white-fronted geese preferred Patterned Wet Meadow and Aquatic Sedge with Deep Polygons in the Colville River Delta (Table 3.3.3-6). Patterned Wet Meadow was also used for nesting at the National Petroleum Reserve-Alaska sites, but Aquatic Sedge with Deep Polygon habitat was not available at these sites (Tables 3.3.3-4 and 3.3.3-6). Brood-rearing and staging geese used Deep Open Water habitats in both areas and Tapped Lakes with Low-Water Connection in the Colville River Delta (this habitat type was not available in the National Petroleum Reserve-Alaska sites) (Tables 3.3.3-4 and 3.3.3-6).

Canada geese nest on small islands in lakes in the Prudhoe Bay area but until recently had not been reported nesting in the Colville River Delta or the National Petroleum Reserve-Alaska (Johnson et al. 1998). In recent years 1 or 2 nests annually have been reported near the Alpine Facilities, and as many as 10 nests were reported in the Plan Area (Johnson et al. 1997, 1998). Nest densities were highest at CD-5 for the National Petroleum Reserve-Alaska sites, with little nesting at the Colville River Delta sites (Table 3.3.3-5). In the Colville River Delta, nesting was on Tapped Lakes, which were not available at the National Petroleum Reserve-Alaska sites; the National Petroleum Reserve-Alaska nesting habitats included Shallow Open Water with Islands and Old Basin Wetland Complex (Table 3.3.3-4).

The largest brant colony on the Arctic Coastal Plain is in the Colville River Delta approximately 12 to 24 km east of the proposed CD-3 development (Johnson et al. 2002). Nest densities were highest at the CD-3 site in the Colville River Delta (Figure 3.3.3.2-4) and at the CD-5 site in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-5 and Table 3.3.3-5). Aquatic Sedge with Deep Polygons was preferred nesting habitat in the Colville River Delta and was used as nesting habitat in the National Petroleum Reserve-Alaska sites (Table 3.3.3-6). During brood-rearing, brant preferred Brackish Water habitats (Table 3.3.3-6). Most brant nests in the area proposed for satellite development are in the northeast portion of the Plan Area, although two additional colonies were located just outside the northeast section of the Plan Area (Burgess et al. 2003b). The remaining portion of the area proposed for satellite development lacks suitable nesting habitat and is farther from the coast than brant are typically found. Ritchie et al. (2002b) reported a brant colony in the Plan Area near the coast west of Fish Creek that varied over years from 25 to 55 nests. From 1995 to 2001, the numbers of brant in the Harrison Bay area during brood-rearing surveys varied from 566 to more than 6,000 birds (Ritchie et al. 2002b).

Snow geese nested at the CD-3 site but were not recorded at any other proposed development site (Table 3.3.3-5). The numbers of snow geese observed during brood-rearing surveys in Harrison Bay have ranged from 50 to more than 600 birds (Ritchie et al. 2002). Small numbers of nests have also been recorded on the outer portions of the Colville River Delta in recent years (Helmericks 2003a, pers. comm.), and a brood-rearing flock was present on the east side of the Delta in 2001 (Noel et al. 2002d).

SWANS (QUGRUK)

NORTH SLOPE

Approximately 20 percent of tundra swans on the Arctic Coastal Plain are in the Northeast National Petroleum Reserve-Alaska during nesting, with almost 20 percent of these within the Plan Area (Table 3.3.3-3). Both tundra swans and swan nests have increased at a mean of approximately 4 percent per year from 1986 to 2002 (Mallek et al. 2003). Ritchie and King (2000) reported a similar upward trend in the numbers of nests and adult swans in the Kuparuk oilfield from 1988 to 1997, although overall nest density did not increase (Ritchie et al. 2002a). Tundra swan concentrations across the Arctic Coastal Plain include areas around Dease Inlet, southeast of Teshekpuk Lake, the Colville River Delta, and east of the Colville River (Figure 3.3.3.2-6). During nesting, tundra swans select deep

Arctophila ponds [Fresh Grass Marsh], and *Arctophila* could be an important food source, although other types of vegetation and invertebrates are also consumed (Derksen et al. 1981). Tundra swan nest mounds, usually situated within 100 meters of large lakes, are often used repeatedly (Stickney et al. 2002). Lakes with complex shorelines could be preferred because they have small coves and sheltered areas that are suitable for emergent vegetation such as *Arctophila* and provide forage and escape cover for swans. During brood-rearing, swans could feed on land, as well as on lakes and ponds, and broods could move overland between lakes (Limpert and Earnst 1994). Tundra swans sometimes congregate into flocks of several hundred birds or more as they stage before fall migration.

PLAN AREA

Tundra swan nest densities were substantially higher in the Colville River Delta than in the National Petroleum Reserve-Alaska portion of the Plan Area (Table 3.3.3-5). Tundra swan nest density was slightly higher at the Alpine Facility than at either CD-3, CD-4 or CD-5 (Figure 3.3.3.2-7 and Table 3.3.3-5). Few tundra swan nests were found near proposed development locations in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-8 and Table 3.3.3-5). Tundra swan nesting and brood-rearing habitat use in the Colville River Delta and the National Petroleum Reserve-Alaska are presented in Table 3.3.3-6. Habitats preferred for nesting and brood-rearing in the Colville River Delta were more diverse than those in the National Petroleum Reserve-Alaska study area, but in both areas tundra swans selected Deep Open Water with Islands for both nesting and brood-rearing (Table 3.3.3-6).

DUCKS

NORTH SLOPE

Fifteen duck species (Table 3.3.3-1) regularly occur on the Arctic Coastal Plain (Mallek et al. 2003). The two most common species are northern pintail and long-tailed duck (Table 3.3.3-3), which together comprise approximately 85 percent of the total Arctic Coastal Plain duck population (Mallek et al. 2003). Other species, including four eider species, occur in much lower densities. Two of the eider species—spectacled eider and Steller’s eider—are federally listed threatened species and are discussed in Section 3.3.5, Endangered and Threatened Species.

Northern pintails are the most numerous duck in the Northeast National Petroleum Reserve-Alaska and in the Plan Area (Table 3.3.3-3). Populations on the Arctic Coastal Plain showed no consistent trend between 1986 and 2002 (Mallek et al. 2003). Two concentration areas of nesting birds occur in the Northeast National Petroleum Reserve - Alaska, both northeast and southeast of Teshekpuk Lake (Figure 3.3.3.2-9). Additional concentration areas are east of Wainwright, south of Barrow, and southeast of Dease Inlet. Northern pintails are found most commonly on *Arctophila* wetlands [Aquatic Grass Marsh], particularly shallow wetlands and beaded streams where *Arctophila* is present, although deep *Arctophila* lakes are used extensively during the brood-rearing period (Derksen et al. 1981).

Eiders use primarily coastal routes during migration and arrive in the Beaufort Sea area in late May and early June. King eiders are the most numerous eider species on the Arctic Coastal Plain (Table 3.3.3-3) (Larned et al. 2003). King eider populations on the Arctic Coastal Plain have shown an increasing trend of 3 percent per year since 1993 (Larned et al. 2003). Fall migration counts of king eiders at Barrow, however, had decreased by 50 percent between the 1970s and 1990s (Suydam et al. 2000). There are two large concentration areas of nesting king eiders on the Arctic Coastal Plain, one northwest of Atqasuk and one south of Teshekpuk Lake extending east to Atigaru Point (Figure 3.3.3.2-10). The largest of these areas, south of Teshekpuk Lake, is within the Northeast National Petroleum Reserve-Alaska and the Plan Area (Figure 3.3.3.2-10). King eiders use shallow and deep *Arctophila* wetlands [Aquatic Grass Marsh] during the nesting period and deep *Arctophila* ponds through July and August during brood-rearing, although some brood-rearing could also occur on shallow *Carex* ponds [Aquatic Sedge Marsh] (Derksen et al. 1981). Higher densities of molting king eiders occur during July in deep-water habitats in Harrison Bay than in nearshore and deep-water habitats from Cape Halkett to Brownlow Point (Fischer et al. 2002).

Approximately 2,500 Pacific-race common eiders (*Somateria mollissima v-nigrum*) occur along the Alaska Beaufort Sea Coast during late June (Table 3.3.3-3) (Dau and Anderson 2002). Fall migration counts of common eiders at Barrow decreased by 50 percent between the 1970s and 1990s (Suydam et al. 2000). Common eiders nest primarily in loose aggregations or colonies on barrier islands, although they also nest on coastal spits or beaches (Gouldie et al. 2000). Nearshore coastal distributions during nesting surveys indicate that breeding pairs of common eiders are most numerous along the central Beaufort Sea Coast between the eastern edge of the Colville River Delta and Brownlow Point (Dau and Anderson 2002). No common eiders used the Plan Area coastline during 2002 (Dau and Anderson 2002). Nest sites are usually associated with driftwood or beach rye grass (*Elymus arenarius*). Common eiders also use manmade causeways and gravel islands in the Prudhoe Bay area for nesting (Johnson 2000b). Common eiders were more common in nearshore waters than offshore waters between Cape Halkett and Brownlow Point, where they were more abundant in areas east of Harrison Bay during June to August (Fischer et al. 2002)

Long-tailed ducks are the second most numerous duck species on the Arctic Coastal Plain (Table 3.3.3-3). Approximately 20 percent of the long-tailed duck population nests in the National Petroleum Reserve-Alaska, with about 5 percent nesting in the Plan Area (Table 3.3.3-3). The Arctic Coastal Plain nesting population of long-tailed ducks showed a declining trend of approximately 3 percent per year between 1985 and 2002 (Mallek et al. 2003). Nesting concentrations are scattered across the Arctic Coastal Plain, with the largest concentration areas east of Deese Inlet and in the southern portion of the Northeast National Petroleum Reserve-Alaska (Figure 3.3.3.2-11). Smaller concentration areas in and near the Plan Area are south of the Kogru River and southeast of the Colville River Delta (Figure 3.3.3.2-11). During the breeding season, long-tailed ducks use shallow *Carex* [Aquatic Sedge Marsh] and shallow Arctophila ponds, as well as deep *Arctophila* wetlands and beaded streams [Aquatic Grass Marsh] (Bergman et al. 1977; Derksen et al. 1981). During brood-rearing almost half of the broods were reported on deep *Arctophila* lakes, with significant numbers also using deep open lakes and shallow *Carex* wetlands (Derksen et al. 1981). After breeding, male long-tailed ducks use coastal lagoons for molting. The density of long-tailed ducks in the shallow waters of Harrison Bay is generally lower than in shallow marine waters from Prudhoe Bay to Brownlow Point (Fischer et al. 2002).

PLAN AREA

Nesting concentrations of northern pintails were highest at CD-4 in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Habitat use was more variable in the Colville River Delta than at the National Petroleum Reserve-Alaska sites, although Aquatic Sedge Marsh with or without Deep Polygons were used for nesting in both areas (Table 3.3.3-6).

King eiders nested at the CD-3 and the Alpine Facility in the Colville River Delta, and pre-nesting eiders appeared to use the outer delta to a greater extent than the inner delta (Figure 3.3.3.2-12). King eider nest densities were highest at CD-7 and CD-5 (Table 3.3.3-5) in the Plan Area, although nests were found clustered between CD-6 and CD-7 (Figure 3.3.3.2-13). Although king eiders nest in the Colville River Delta, they could be more common as a nesting species in areas east and west of the Delta (Figure 3.3.3.2-12). Pre-nesting king eider densities increase from the Fish Creek Delta westward across the central portion of the Plan Area, consistent with the concentration area shown on Figure 3.3.3.2-13 (Noel et al. 2001).

A few common eiders have been observed in the outer Colville River Delta (Figure 3.3.3.2-12). They were not reported nesting at any of the Colville River Delta or the National Petroleum Reserve-Alaska sites proposed for development (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b). Common eiders were less common in the shallow waters of Harrison Bay than in the shallow marine waters from Prudhoe Bay to Brownlow Point during June to August.

Long-tailed ducks nested at all proposed pad locations (Table 3.3.3-5and Figure 3.3.3.2-14), with the highest nesting density at CD-3 and the lowest density at CD-4 in the Colville River Delta. Long-tailed ducks used a wide variety of habitats for nesting, but used Shallow Open Water with Islands and Aquatic Sedge habitats in both the Colville River Delta and the National Petroleum Reserve-Alaska (Table 3.3.3-6).

3.3.3.3 Loons (Malgitch)

NORTH SLOPE

Three loon species, Pacific, red-throated, and yellow-billed, breed on the North Slope. Loons arrive on the North Slope in late May and establish breeding territories on tundra lakes and ponds as soon these habitats are free of ice and snow (Table 3.3.3-2). After nesting, loons could move to marine habitats before migration in August and September (Johnson and Herter 1989).

Red-throated loons are much less common than Pacific loons on the Arctic Coastal Plain (Table 3.3.3-3). Mallek et al. (2003) reports an increase in the numbers of red-throated loons on the Arctic Coastal Plain from 1986 to 2002. The largest concentration area for red-throated loons appears east of the Northeast National Petroleum Reserve-Alaska, with two small concentrations in the Plan Area (Figure 3.3.3.3-1). Red-throated loons use shallow *Arctophila* wetlands [Aquatic Grass Marsh] that are usually situated near the coast or near large lakes with fish (Derksen et al. 1981). Red-throated loons regularly forage away from their nesting pond, flying to larger lakes or to marine habitats to feed and to bring fish back to their young (Barr et al. 2000).

The Pacific loon is the most abundant loon species across the Arctic Coastal Plain (Table 3.3.3-3), and aerial surveys during the last 10 years have indicated that the population is stable (Mallek et al. 2003). Most of the largest concentration areas for Pacific loons are outside of the Northeast National Petroleum Reserve-Alaska, with two small concentrations and a part of one large concentration within the Plan Area (Figure 3.3.3.3-2). Pacific loons nest on small islands and vegetation platforms near the water's edge (Kertell 1994, 2000), and nests most frequently are found on deep *Arctophila* lakes [Deep Open Water with Islands or Polygonized Margins] and to a lesser extent on deep open lakes [Deep Open Water without Islands] (Bergman et al. 1977; Derksen et al. 1981). Pacific loons exhibit site fidelity to breeding locations, often returning to the same lake or pond in successive years (Kertell 2000).

The yellow-billed loon is the least abundant loon species on the Arctic Coastal Plain (Table 3.3.3-3), and the population growth rate has shown no trend from 1986 to 2002 (Mallek et al. 2003). The largest concentration area for yellow-billed loons is southeast of Deese Inlet, with a lower concentration area in the northwest corner of the Plan Area (Figure 3.3.3.3-3). Yellow-billed loons nest on deep open lakes and deep *Arctophila* lakes [Deep Open Water with Islands or Polygonized Margins] that are generally larger than those used by other loon species (Derksen et al. 1981; North 1986; Burgess et al. 2003b; Johnson et al. 2003b), although nests could also occur on smaller wetlands adjacent to large lakes (North 1986; Burgess et al. 2003b; Johnson et al. 2003b). Yellow-billed loon nests are constructed on islands and along the shoreline where adults feed on fish and invertebrates, and nest sites might be reused in subsequent years (North 1994). Pairs that nest in small lakes could move broods overland to nearby larger lakes (North 1986).

PLAN AREA

Red-throated loons are much less common than Pacific loons in the Northeast National Petroleum Reserve-Alaska, as well as in the Plan Area (Table 3.3.3-3) (Noel et al. 2002; Burgess et al. 2003a, 2003b). The highest nesting densities of red-throated loons in the Plan Area have been recorded near CD-3 in the Colville River Delta (Figure 3.3.3.3-4 and Table 3.3.3-5), where they used a variety of wetlands habitats for nesting and brood-rearing (Table 3.3.3-6) (Johnson et al. 2003b). Red-throated loon nests are found only at CD-5 for the National Petroleum Reserve-Alaska sites (Figure 3.3.3.3-5), where Old Basin Wetland Complex habitats were used for both nesting and brood-rearing (Table 3.3.3-6). Offshore transects conducted between Cape Halkett and Brownlow Point from June through August found that red-throated loons used the Harrison Bay shallow area primarily during July, and the Harrison Bay deep area during August (Fisher et al. 2002).

Pacific loons are the most abundant loon species in the Plan Area (Table 3.3.3-3; Noel et al. 2001, 2002c; Burgess et al. 2003b). Pacific loons nest in a wide variety of habitats throughout the Plan Area (Table 3.3.3-6). In the Colville River Delta, Pacific loons used brackish water and tapped lakes with high-water connections for both nesting and brood-rearing, habitats that were not available at the National Petroleum Reserve-Alaska sites (Figure 3.3.3.3-4 and Table 3.3.3-4). In the National Petroleum Reserve-Alaska sites, Pacific loon nest densities were highest at CD-5 and

CD-7 (Figure 3.3.3.3-5 and Table 3.3.3-5), where loons used Shallow-Open Water with Islands and Aquatic Sedge Marsh for both nesting and brood-rearing (Table 3.3.3-6). These habitats were rare at the Colville River Delta sites (Table 3.3.3-4). Andres (1993) reported that Pacific loons in the Colville River Delta portion of the Plan Area made frequent foraging trips to marine habitats, particularly during brood-rearing. Pacific loons were the most abundant loon species observed during offshore surveys between Cape Halkett and Brownlow Point, with consistent use of the Harrison Bay shallow areas (Fischer et al. 2002).

Densities of nesting yellow-billed loons were highest at CD-3 and CD-7 (Table 3.3.3-5), but were still low in these areas. The Colville River Delta is an important nesting area for yellow-billed loons (Figure 3.3.3.3-4), according to North and Ryan (1988) and Johnson et al. (1999), whose surveys were mainly in the Delta habitats. Surveys in the Fish and Judy creek drainages identified concentrations of nests near these streams in the National Petroleum Reserve-Alaska (Figure 3.3.3.3-5) (Burgess et al. 2003b). The nesting population in the Fish and Judy creek drainages could be as large or larger than the Colville River Delta nesting population (Burgess 2003, pers. comm.; Burgess et al. 2003b; Johnson et al. 2003b). Yellow-billed loons selected Deep Open Water with Islands or Polygonized Margins for both nesting and brood-rearing in the Colville River Delta and at the National Petroleum Reserve-Alaska sites (Table 3.3.3-6). This habitat was relatively rare in both the Colville River Delta (1.4 percent of available habitats) and at the National Petroleum Reserve-Alaska sites (5.2 percent of available habitats) when searched for nests (Table 3.3.3-4). Fischer et al. (2002) reported that densities of yellow-billed loons were significantly higher in the shallow waters of Harrison Bay during the summer than in seven other shallow and deepwater areas between Cape Halkett and Bullen Point.

3.3.3.4 Ptarmigan

NORTH SLOPE

Two species of ptarmigan, willow and rock, are found in the Plan Area. Ptarmigan are ground-nesting birds in the grouse family that could remain on the Arctic Coastal Plain as year-round residents. Rock ptarmigan could conduct local migrations during the fall to obtain willow forage (Johnson and Herter 1989). These species are not generally recorded during aerial surveys for birds on the Arctic Coastal Plain (Larned et al. 2003; Mallek et al. 2003).

PLAN AREA

Noel et al. (2001) reported that willow ptarmigan were far more abundant in the eastern National Petroleum Reserve-Alaska than rock ptarmigan, and Johnson et al. (2003a) reported higher nest densities for willow ptarmigan than for rock ptarmigan in the CD-3, CD-4, and ASDP study areas in the Colville River Delta. Burgess et al. (2003b) found only willow ptarmigan nesting at CD-5 and CD-6 in the National Petroleum Reserve-Alaska, although some unidentified ptarmigan nests were also reported (Table 3.3.3-5). Ptarmigan used Patterned Wet Meadow and Moist Sedge-Shrub habitats for nesting, and Moist Sedge-Shrub habitats for brood-rearing at both the Colville River Delta and at the National Petroleum Reserve-Alaska sites (Burgess et al. 2003 a, b; Johnson et al. 2003a).

3.3.3.5 Raptors and Owls

NORTH SLOPE

Raptors are birds of prey that include falcons, hawks, eagles, and owls. The snowy owl and gyrfalcon are the only raptors known to overwinter on the Arctic Coastal Plain; all others migrate south to overwinter (Johnson and Herter 1989). Most raptors on the North Slope are cliff-nesting species, but the northern harrier, snowy owl, and short-eared owl nest on the ground. The arctic peregrine falcon (*Falco peregrinus tundrius*) was removed from the Endangered Species List in 1994, with monitoring of the population required until 1999 (59 FR 50796). The gyrfalcon is an uncommon species on the Arctic Coastal Plain but is a fairly common nesting species south of the Plan Area in the foothills of the Brooks Range and on cliffs and bluffs along the Colville River (Figure 3.3.3.5-1). Gyrfalcons use nests constructed by rough-legged hawks or ravens in previous years (Johnson and Herter 1989, and references therein). Gyrfalcons have used abandoned raven nests on artificial structures such as the trans-Alaska pipeline (Ritchie 1991). The rough-legged hawk nests in the Brooks Range and along the cliffs and bluffs of the Colville River (Figure 3.3.3.5-1). Ritchie (1991) also reported a rough-legged hawk nest on tundra near the Dalton Highway. Rough-legged hawks have also been reported using manmade structures for nest sites (Ritchie, 1991). Golden eagles nest in the Brooks Range, but they are not known to nest in the Plan Area (Ritchie 2003, pers. comm.). Although the main prey of the golden eagle is the arctic ground squirrel, they are also known to prey on newborn caribou calves during spring (Johnson and Herter 1989). Bald eagles and merlins also are occasionally observed on the Arctic Coastal Plain.

Ground-nesting raptors on the Arctic Coastal Plain include snowy and short-eared owls and the northern harrier (Table 3.3.3-5). These species breed irregularly across the Arctic Coastal Plain and are most common during highs in microtine rodent populations.

PLAN AREA

Three falcon species—peregrine falcon, gyrfalcon, and merlin—occur in small numbers in the Plan Area. Hawks in the Plan Area include the rough-legged hawk and northern harrier. Golden and bald eagles could also range into the area. Two owl species, snowy and short-eared, also nest in the Plan Area. Arctic peregrine falcons nest along the Colville River south of Ocean Point (Figure 3.3.3.5-1). Five to nine peregrine nests have been reported in this area annually since 1999 (Swem 2003, pers. comm.). Arctic peregrine falcons have also been reported nesting in the Plan Area near the CD-7 site (Figure 3.3.3.5-1) (Johnson and Stickney, 2001; Burgess et al. 2002a) and apparently are expanding their range on the Arctic Coastal Plain (Ritchie and Wildman 2002). The gyrfalcon is a fairly common nesting species south of the Plan Area in the foothills of the Brooks Range and on cliffs and bluffs along the Colville River. No recent nests were reported for the portion of the CRSA within the Plan Area (Figure 3.3.3.5-1). Rough-legged hawks nest in the Brooks Range and along the cliffs and bluffs of the Colville and other rivers. Since 1999, three to nine nests have been reported annually in the portion of the CRSA within the Plan Area (Figure 3.3.3.5-1) (Swem 2003, pers. comm). Bald eagles and merlins are uncommon visitors in the Plan Area.

Ground-nesting raptors that occur and breed irregularly in the Plan Area include snowy and short-eared owls and northern harrier. Northern harriers and short-eared owls have nested at CD-4. Short-eared owls have also nested at CD-2. (Figure 3.3.3.5-1 and Table 3.3.3-5)

3.3.3.6 Shorebirds

NORTH SLOPE

The North Slope provides some of the most productive shorebird habitat in northern Alaska. More than 30 species of shorebirds are known to breed on the North Slope, and as many as 6 million shorebirds are thought to spend the summer there (Cotter and Andres 2000). In general, shorebirds are present on the North Slope from May to September. After hatching, brood-rearing shorebirds move to tundra and aquatic habitats adjacent to their nests. Many shorebirds move to coastal habitats to feed after young have fledged and before migrating during late August and September (Andres 1994; Johnson and Herter 1989; PAI 2002a, Appendix B). Shorebird nesting densities on the Arctic Coastal Plain could range from 65 nests/Square kilometer ($km^{2)}$ in the Point McIntyre area (TERA 1993) to 163 nests/km^2 at the Alpine Facility (Johnson et al. 2003a). Shorebird nest densities within the Plan Area were within the range of densities (12 to 80 nests/km^2) found across the National Petroleum Reserve-Alaska (Cotter and Andres 2000). Shorebird nesting is variable not only from place to place but also year to year depending on weather (Troy 2000). Post-breeding shorebirds (150 birds/km^2) use the lower Colville River Delta, within 6 km of the Delta's northern edge, more heavily than any other North Slope site (Andres 1994).

PLAN AREA

Nine shorebird species are common breeders, seven species are uncommon breeders and four species are rare breeders in the Plan Area (Table 3.3.3-1) (PAI 2002a, Appendix B, Table B-3; BLM and MMS 1998a, Table III.B.4-4). The discussion of shorebirds within the Plan Area focuses on common or regularly occuring species, although some uncommon species are mentioned if they are considered sensitive or of special concern to regulatory agencies. Common shorebirds within the proposed development area fall largely within the plover and sandpiper/phalarope families. Nest densities based on shorebird plots near proposed development areas in the National Petroleum Reserve-Alaska and at the Alpine Facility in the Colville River Delta are presented in Table 3.3.3-7. Approximately 41,000 post-breeding shorebirds (assuming a complete turnover every seven days) use primarily shoreline silt barrens [Tidal Flat] and sparsly vegetated salt marshes [Salt Marsh] in the lower Colville River Delta during July and August (Andres 1994). Andres (1994) found that dunlins (48 percent) dominated post-breeding shorebird use of the lower Colville River Delta followed by semipalmated sandpipers (22 percent), red-necked phalarope (10 percent), western sandpiper (6 percent), pectoral sandpiper (4 percent) and stilt sandpiper (4 percent).

TABLE 3.3.3-7 NEST DENSITIES (NESTS/KM^2) FROM SHOREBIRD PLOTS IN THE PLAN AREA

Species	Colville River Delta	National Petroleum Reserve-Alaska Sites			
		Alpine West	Lookout	Spark	National Petroleum Reserve-Alaska Area (3-year mean)[e]
	Alpine[a]	CD-5 (3-year mean)[b]	CD-6 (2-year mean)[c]	CD-7 (3-year mean)[d]	
Shorebirds					
Black-bellied plover	1.7	0.6	0	0.3	2.0
American golden-plover	2.1	0.8	1.3	0	1.3
Bar-tailed godwit	0.4	0.3	0.6	0	0.5
Semipalmated sandpiper	19.6	3.3	2.5	2.5	11.4
Baird's sandpiper	0	0	0	0	0.1
Pectoral sandpiper	37.1	7.2	5.6	5.6	10.7
Dunlin	1.3	0.8	1.3	0	1.6
Stilt sandpiper	1.7	2.8	0	0	1.8
Buff-breasted sandpiper	0	0	<0.1	0	0.8
Long-billed dowitcher	2.9	3.1	2.5	0.8	5.1
Red-necked phalarope	9.2	2.5	1.9	4.7	5.4
Red phalarope	6.3	3.6	0	1.1	2.9
Passerines					
Yellow wagtail	0.4	0	0	0	0.3
Savannah sparrow	2.1	0	0.6	1.7	1.9
Lapland longspur	37.5	8.1	18.1	9.2	25.1
Common redpoll	0.4	0.8	0.6	0	1.4

Notes:

[a] 4-year mean from 6 Reference Plots (Johnson et al. 2003a)

[b] 3-year mean from 4 Plots (Burgess et al. 2003b, Johnson et al. 2004)

[c] 2-year mean from 4 plots (Burgess et al. 2003b, Johnson et al. 2004)

[d] 3-year mean from 4 Plots (Burgess et al. 2003b, Johnson et al. 2004)

[e] 3-year mean from 24 plots (Burgess et al. 2003b, Johnson et al. 2004)

PLOVERS

Plovers that are considered common in the Plan Area include the black-bellied plover and American golden-plover (Table 3.3.3-1). Plovers tend to nest on upland sites that are drier than those used by other shorebirds (Johnson and Herter 1989; PAI 2002a, Appendix B). Black-bellied plovers breed most commonly near the coast and tend to nest in dry tundra habitats next to wet areas (Derksen et al. 1981; Johnson and Herter 1989). Brood-rearing also occurs on wet tundra habitats. Nesting densities for black-bellied plovers in the Plan Area were higher at the National Petroleum Reserve-Alaska sites than at the Alpine Facility in the Colville River Delta (Table 3.3.3-7). The American golden-plover commonly breeds at both coastal and inland locations (Johnson and Herter 1989). They prefer to nest in dry upland tundra areas but will move to moist or wet sedge tundra areas for brood-rearing (Troy 2000). Nesting densities within the Plan Area were highest at CD-5 and CD-6 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). More Moist Tussock Tundra habitats are available in the National Petroleum Reserve-Alaska area than near the Alpine Facility (Table 3.3.3-4).

SANDPIPERS AND PHALAROPES

Sandpipers and phalaropes considered abundant to common in the Plan Area include dunlin, semipalmated sandpiper, pectoral sandpiper, long-billed dowitcher, red-necked phalarope, and red phalarope (Table 3.3.3-1). These shorebird species use a wide variety of habitat types but tend to nest in Wet Sedge Meadows and Aquatic Sedge and Grass Marshes. Shorebird nests, including pectoral and semipalmated sandpipers, occurred most frequently in Patterned Wet Meadow and Moist Sedge-Shrub Meadow habitats near the Alpine Facility in the Colville River Delta (Johnson et al. 2003a). Dunlins and semipalmated sandpipers also nest in Moist Tussock Tundra habitats (Johnson and Herter 1989; PAI 2002a, Appendix B).

Dunlins use a wide range of habitat types but are more abundant near the coast than inland (Derksen et al. 1981; Johnson and Herter 1989). Nesting densities were highest in the National Petroleum Reserve-Alaska, at CD-6 and in the Colville River Delta (Table 3.3.3-7), where dunlins used Moist Tussock Tundra and Patterned Wet Meadow habitats. Fledglings move to coastal areas during late July and early August, while adults move to upland areas for flocking and departure to the coast. During post-breeding shorebird surveys in the Colville River Delta, dunlins were approximately 50 percent of all sightings and were most abundant on coastal shoreline silt barrens (Andres 1994).

Pectoral sandpipers nest in highest densities in wet or moist tundra with low-centered polygons in the Prudhoe Bay region (Troy 1988). Shorebird studies in the National Petroleum Reserve-Alaska near Inigok (Cotter and Andres 2000) found pectoral sandpipers nesting exclusively in drained lake basins. Nest densities in the Plan Area were highest at the Alpine Facility in the Colville River Delta, followed by CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Post-breeding males and females and fledged young move toward the coast from mid- to late July before migration (Derksen et al. 1981).

Semipalmated sandpipers were less abundant at both the Colville River Delta and the National Petroleum Reserve-Alaska sites than pectoral sandpipers (Table 3.3.3-7). They use both inland tundra and coastal habitats throughout the season, nesting on wet tundra, well-drained tundra, and dry tundra (Derksen et al. 1981). Shorebird studies in the National Petroleum Reserve-Alaska near Inigok (Cotter and Andres 2000) found semipalmated sandpipers nesting exclusively in drained lake basins. Semipalmated sandpipers were 22 percent of all sightings during post-breeding shorebird surveys in the Colville River Delta (Andres 1994).

Long-billed dowitchers use a variety of nesting habitats across the Arctic Coastal Plain, but appear to prefer wet habitats associated with strangmoor (Troy 2000). Long-billed dowitchers were found nesting at all of the proposed development locations in the Plan Area, with the highest nest densities near CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7).

Red phalaropes are less common in the Plan Area than red-necked phalaropes. Red-necked phalaropes nest at higher densities at inland wet-tundra locations than at coastal sites (Derksen et al. 1981). Nest densities for red-necked phalaropes were highest at CD-7 and CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Red phalaropes prefer wet non-patterned tundra and aquatic tundra with strangmoor ridges for nesting in Prudhoe Bay (Troy 1988). Nest densities of red phalaropes in the Plan Area were highest in the Colville River Delta and near CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). These sites contain higher proportions of Patterned Wet Meadow (analogous to aquatic tundra with strangmoor ridges) than either the Alpine Facility or CD-6 and CD-7 (Table 3.3.3-4).

The red knot is considered an uncommon migrant and locally uncommon breeder in the Beaufort Sea area and a casual migrant to the Colville River Delta. Records of single birds or small groups are the rule over most of the North Slope (Johnson and Herter 1989; PAI 2002a, Appendix B). No red knot nests were recorded during shorebird studies at sites in the Colville River Delta and the National Petroleum Reserve-Alaska (Table 3.3.3-7).

Buff-breasted sandpipers tend to use drier habitat than do other shorebirds and are considered part of the "upland" species guild (with American golden-plovers, dunlins, and Baird's sandpipers) because of their dependence on drier sloping areas or polygonal featured tundra (Lanctot and Laredo 1994). Lanctot and Laredo (1994) described the habitat use of the buff-breasted sandpiper by sex and breeding stage based on the results of previous studies. Displaying males first occur in areas free of snow such as barren ridges, creek bands, and raised, well-drained areas with reticulate-patterned ground and sparse vegetation (such as *Dryas* sp.) [Barrens, Partially Vegetated and Dryas Dwarf Shrub Tundra]. Within 3 to 5 days of their arrival, most males are found displaying together in leks on non-patterned ground, moist sedge and cottongrass meadows with closely spaced tussocks and with dwarf willow thickets [Moist Sedge-shrub Meadow; Patterned Wet Meadow]. Most males abandon these sites within 1 to 2 weeks to display closer to nest sites, typically on dry slopes with numerous sedge tussocks [Moist Sedge-Shrub Meadow], on moss-willow-varied tussocks [Moist Tussock Tundra], and in moist or wet sedge-graminoid meadows on non-patterned or strangmoor ground [Wet Sedge Meadow Tundra]. Brood-rearing females have been seen in moist and emergent vegetation along and in stream beds [Riverine Complex, Aquatic Sedge and Grass Marsh]. Buff-breasted sandpiper nests were found in the National Petroleum Reserve-Alaska area near CD-6 (Table 3.3.3-7) (Burgess et al. 2003b).

Bar-tailed godwit nests have been recorded at the Alpine Facility in the Colville River Delta and at CD-5 and CD-6 in the National Petroleum Reserve-Alaska, where nests were primarily in Patterned Wet Meadow habitats (Table 3.3.3-7) (Burgess et al. 2003b). Nest densities were highest at CD-6 (Table 3.3.3-7).

3.3.3.7 Seabirds

Six species of seabirds common across the Arctic Coastal Plain are likely to occur in the Plan Area: glaucous and Sabine's gulls; pomarine, parasitic, and long-tailed jaegers; and arctic tern (Table 3.3.3-3). Most seabirds arrive on the Arctic Coastal Plain in early to late May and leave in September to November (Table 3.3.3-3). In addition, the black guillemot could occur in offshore areas (Johnson and Herter 1989).

NORTH SLOPE

Jaegers are on the open sea during the winter but migrate to tundra breeding grounds during the summer. The Arctic Coastal Plain population of jaegers shows no significant trends, remaining relatively stable at approximately 3,800 individuals (Table 3.3.3-3) (Larned et al. 2003). Parasitic jaegers are predators of eggs and young of waterfowl and tundra-nesting shorebirds and passerines, as well as small mammals (Maher 1974). Long-tailed jaegers consume fewer small mammals and birds and more insects than other jaegers. Pomarine jaegers feed primarily on lemmings and will not breed unless the lemming population is high (Maher 1974).

Glaucous gulls are a common migrant and breeder on the Arctic Coastal Plain (Table 3.3.3-3). Glaucous gulls nest across the Arctic Coastal Plain, with concentrations both east and west of Dease Inlet and on barrier islands (Figure 3.3.3.7-1) (Irving 1960; Sage 1974). The glaucous gull population on the Arctic Coastal Plain has remained stable since 1992 (Larned et al. 2003). Nests in mainland areas are often on small islands in lakes, and pairs could nest singly or in small colonies. Glaucous gulls depart the breeding grounds by mid-September and migrate westward along the coast. While on the breeding grounds, glaucous gulls are opportunistic feeders, preying on eggs and chicks of other bird species, particularly waterfowl (Johnson and Herter 1989). In addition, they feed extensively in the marine environment on prey that includes fish, isopods, and worms. Glaucous gulls also scavenge along shorelines and in areas of human habitation, and coastal surveys indicate that many glaucous gulls occur on transects adjacent to coastal villages (Dau and Anderson 2002).

Sabine's gulls are less common than glaucous gulls on the Arctic Coastal Plain and nest in single pairs or small colonies on the shores or islands of tundra lakes (Table 3.3.3-3) (Johnson and Herter 1989; Noel et al. 2001). The

Arctic Coastal Plain population of Sabine's gulls fluctuated between 5,000 and 8,000 birds between 1992 and 2002, except for a low of 2,800 birds in 1998 (Larned et al. 2003). They feed on a variety of small fish, insects, and other invertebrates (Ehrlich et al. 1988).

The arctic tern is a fairly common breeder and migrant in the Beaufort Sea area that nests most commonly near the coast but could also nest inland (Table 3.3.3-3) (Johnson and Herter 1989). Arctic terns increased by approximately 7 percent per year on the Arctic Coastal Plain between 1992 and 2002 (Larned et al. 2003). Arctic terns nest on islands in tundra lakes and ponds, on barrier islands, and on gravel bars along lakes and rivers—often in areas where there is little or no vegetation. Arctic terns sometimes nest colonially with other terns, gulls, and waterfowl.

PLAN AREA

Parasitic and long-tailed jaegers have been recorded breeding in the Plan Area in small numbers (Table 3.3.3-5) (Burgess et al. 2002a, 2003b; Johnson et al. 2002). Pomarine jaegers have not nested in the Plan Area during recent years. Pomarine jaegers are more common west of the Plan Area but could be common in the Plan Area during migration (Johnson and Herter 1989).

The number of glaucous gulls in the Plan Area has doubled or tripled in the last 40 years, with a new colony of 25 to 30 pairs established about 4 miles southeast of the Alpine Facility (Figure 3.3.3.7-2), after construction (J. Helmericks 2004 pers. comm.). Glaucous gulls are scattered throughout most of the Plan Area, with the highest nesting densities at CD-5 and CD-7 in the National Petroleum Reserve-Alaska (Figure 3.3.3.7-3) and CD-3 in the Colville River Delta (Figure 3.3.3.7-2 and Table 3.3.3-5). Nesting habitats used within both the National Petroleum Reserve-Alaska and the Colville River Delta sites included Deep Open Water with Islands (Table 3.3.3-6). In the Colville River Delta glaucous gulls also used Brackish Water for nesting and brood-rearing (Table 3.3.3-6). Glaucous gulls were common in shallow-water strata between Cape Halkett and Brownlow Point, but showed a westward shift in distribution from June to August (Fischer et al. 2002). Glaucous gulls were generally more concentrated in shallow water areas to the east of Harrison Bay and the Colville River Delta (Fischer et al. 2002). Concentrations of non-breeding glaucous gulls around landfill sites are common, and there has been speculation that breeding gulls near coastal villages might benefit from landfills as an additional food source (Day 1998). Glaucous gulls have also been observed feeding on fish wastes and fishing nets lost during winter near the Alpine pipeline crossing on the Colville River (J. Helmericks 2004 pers. comm.).

A few Sabine's gull nests have been recorded at CD-3 and the Alpine Facility in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Sabine's gulls nested in a wider variety of habitats at the Colville River Delta sites than at the National Petroleum Reserve-Alaska sites, although they used Shallow Open Water with Islands in both areas (Table 3.3.3-6).

Arctic terns nested at all proposed development locations (Table 3.3.3-5). The highest nesting densities were at CD-3 in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Arctic terns used a wider variety of nesting habitats in the Colville River Delta than in National Petroleum Reserve-Alaska; however, they used Shallow Open Water with Islands habitats in both areas (Table 3.3.3-6).

3.3.3.8 Passerines

NORTH SLOPE

Most passerines found on the Arctic Coastal Plain winter in temperate and tropical regions in the Americas or southern Asia (BLM and MMS 1998a). They generally arrive on the North Slope from late May to early June and remain until mid- to late August (Johnson and Herter 1989). With the exception of the common raven, passerines on the North Slope are a tundra-nesting species. Their nests are built on the ground, frequently in the shelter of an overhanging bank, bush, or grass clump (Johnson and Herter 1989). Table 3.3.3-8 presents nesting and foraging habitats used by passerines.

TABLE 3.3.3-8 NESTING AND FORAGING HABITATS USED BY PASSERINES IN THE PLAN AREA

Species	Nesting Habitat	Foraging Habitat
Common raven	Cliffs, communications towers, oilfield infrastructure	Opportunistic and highly variable
Yellow wagtail	Willow shrub tundra or tussock tundra under an overhang	Open tundra and willow thickets
Savannah sparrow	Open sedge tundra	Sedge and other open tundra
Lapland longspur	Tundra habitats	Tundra habitats
Common redpoll	Shrub tundra	Tundra habitats and shrub thickets

Sources: Armstrong 1995

The common raven is the only resident species that is likely to occur in the Plan Area (Table 3.3.3-1) (PAI 2002a, Appendix B, Table B-3; BLM and MMS 1998a). Common ravens are common in the foothills and mountains of the Brooks Range south of the Plan Area. They nest on cliffs where they construct nests that could be used in subsequent years by rough-legged hawks or gyrfalcons (Johnson and Herter 1989). Before human development on the Arctic Coastal Plain, common ravens were uncommon and rare nesters because of the lack of suitable nesting habitat. However, over the past several decades common ravens have become much more abundant on the Arctic Coastal Plain, including the Northeast National Petroleum Reserve-Alaska Plan Area, as nesting habitat in the form of towers, antennas, drill rigs, buildings, and other tall structures have become more abundant (Johnson and Herter 1989). Some common ravens overwinter on the Arctic Coastal Plain and in the Plan Area near anthropogenic food sources (Helmericks 2003a, pers. comm.). As their numbers have increased, common ravens have become common predators of tundra-nesting birds on the Arctic Coastal Plain in general (Day 1998), and in the Plan Area (Helmericks 2003b, pers. comm.).

PLAN AREA

At least 10 species of passerines occur in the Plan Area (Table 3.3.3-1). Of these, seven are known or probable breeders; however, only four species, the yellow wagtail, Savannah sparrow, Lapland longspur, and common redpoll, are common to abundant breeders in the Plan Area (Table 3.3.3-1).

Lapland longspurs are the most abundant passerine species in the Plan Area (Derksen et al. 1981), where they nested in higher densities than any other bird species at almost all sites sampled in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Recent breeding bird surveys conducted near CD-5, CD-6, and CD-7 in the National Petroleum Reserve-Alaska found four species of nesting passerines: the yellow wagtail, Savannah sparrow, Lapland longspur, and common redpoll (Burgess et al. 2002b, 2003b, Johnson et al. 2004). The Lapland longspur was the most abundant passerine at all the National Petroleum Reserve-Alaska sites, representing 90 percent of the nests (Table 3.3.3-7). These same four passerine species also nested at the Alpine Facility in the Colville River Delta, where the Lapland longspur was again the most abundant species, representing 83 percent of the nests recorded (Table 3.3.3-7) (Johnson et al. 2003a).

Common ravens first began nesting in the vicinity of the Plan Area in the late 1950s, when a nest was established on the microwave tower at the Oliktok DEW Line Station. However, common ravens have become much more numerous during the late 1990s with a total of 20 individuals recorded (J. Helmericks 2004, pers. comm.). Common ravens were rarely observed in the area of the Alpine Facility before 1998, when they first used buildings as roosting sites, and a nest was suspected but not confirmed (Johnson et al. 2003a). Nesting at the Alpine Facility was confirmed in 2000 and 2001, although no increase in rates or sources of loon and waterfowl nest depredation were found after construction of the Alpine Facility (Johnson et al. 2003a). Common ravens nesting at Alpine, Nuiqsut and Meltwater, based on flight directions, reduced nesting success up to 26 miles away at the Anachlik nesting colony by as much as 80 percent in 2003 (J. Helmericks 2004, pers. comm.). A common raven nest was also established on the well head at CD-7 in the National Petroleum Reserve-Alaska; this nest was later removed and a cover was installed to prevent further nesting (C. Rea 2003, pers. comm.).

3.3.4 Mammals

3.3.4.1 Terrestrial Mammals

Terrestrial mammals in the Plan Area include caribou, muskoxen, moose, grizzly bear, arctic fox, red fox, wolverine, gray wolf, and small mammals including the arctic ground squirrel, ermine, least weasel, lemmings, voles, and shrews (BLM and MMS 1998a, 2003; BLM 2002a; TAPS Owners 2001a; Truett and Johnson 2000; PAI 2002a). These species occur across the North Slope and in many other parts of Alaska and are listed in Table 3.3.4-1. Polar bears occur in the Plan Area, but they are generally considered marine mammals and are described in Section 3.3.4.2.

No terrestrial mammals in the Plan Area are listed under the federal or State of Alaska Endangered Species Acts (TAPS Owners 2001a; BLM and MMS 1998a, 2003; PAI 2002a). The only terrestrial mammal species on the BLM Sensitive Species list that might occur in the Plan Area is the Canada lynx. Lynx occur at low densities in the mountains and foothills of the Brooks Range and are generally not found on the coastal plain, including the Plan Area (Carroll 1998) so they are not discussed further.

TABLE 3.3.4-1 MAMMAL SPECIES KNOWN OR SUSPECTED TO OCCUR IN THE REGION OF THE COLVILLE RIVER DELTA, ALASKA

Common Name	Scientific Name	Inupiaq Name	Abundance
Large Mammals			
Lynx	*Lynx canadensis*	niutuiyiq	rare
Caribou	*Rangifer tarandus*	tuttu	abundant
Muskox	*Ovibos moschatus*	umifmak	common
Moose	*Alces alces*	tuttuvak	uncommon
Grizzly (brown) bear	*Ursus arctos*	akjaq	common
Gray wolf	*Canis lupus*	amabuq	rare
Wolverine	*Gulo gulo*	qavvik	uncommon
Arctic fox	*Alopex lagopus*	tibiganniaq	common
Red fox	*Vulpes vulpes*	kayuqtuq	uncommon
Small Mammals			
Arctic ground squirrel	*Spermophilus parryii*	siksrik, sigrik	abundant
Ermine (short-tailed weasel)	*Mustela erminea*	itibiaq	common
Least weasel	*Mustela nivalis*	naulayuq	uncommon
Tundra hare	*Lepus othus*	ukallisugruk	rare
Snowshoe hare	*Lepus americanus*	ukalliatchiaq	rare
Brown lemming	*Lemmus trimucronatus*	aviffapiaq	uncommon
Collared lemming	*Dicrostonyx groenlandicus*	qixafmiutaq	common
Northern red-backed vole	*Clethrionomys rutilus*	aviffaq	rare?
Tundra vole	*Microtus oeconomus*	aviffaq	uncommon
Singing vole	*Microtus miurus*	aviffaq	common
Barrenground shrew	*Sorex ugyunak*	ugrugnaq	common?
Tundra shrew	*Sorex tundrensis*	ugrugnaq	uncommon?
Other Mammals			
Mink	*Mustela vison*	itibiaqpak	rare
River otter	*Lontra canadensis*	pamiuqtuuq	rare
Porcupine	*Erethizon dorsatum*	qifabluk	rare
Coyote	*Canis latrans*	amabuuraq	rare

Source: This table was modified from Table B-8 of PAI 2002a

Notes: ? indicates that occurrence in the Plan Area is uncertain; and species designated as rare are at the limit of their range

CARIBOU

NORTH SLOPE

There are four caribou herds in arctic Alaska; from west to east they are the Western Arctic Herd (WAH), the Teshekpuk Lake Herd (TCH), the Central Arctic Herd (CAH), and the Porcupine Caribou Herd (PCH). Caribou of the TCH and CAH have a portion of their ranges in the Plan Area (Figure 3.3.4.1-1). The Plan Area is peripheral range for the PCH and WAH (BLM and MMS 2003) and information on these herds is available in other documents (BLM and MMS 1998a, 2003; USGS 2002).

Caribou herds are defined by the geographic location of their calving areas. Cow caribou of the North Slope herds have fidelity to calving areas although there may be overlap of other seasonal ranges and interbreeding between different herds (Skoog 1968; Whitten and Cameron 1983; Bergerud et al. 1984; Davis et al. 1986; Cameron and Whitten 1986; Prichard et al. 2001; Cronin et al. 2003). In general, it can be expected that the impact of the proposed developments will be the same to any caribou, regardless of their herd designation. A possible exception is the caribou of the CAH that may be habituated to the existing oilfields at Prudhoe Bay and the surrounding area.

TESHEKPUK LAKE HERD

Population Status and Range

The TCH was recognized as a separate herd from the WAH and CAH in the mid-1970s (Davis and Valkenburg 1978). The primary range of the TCH is the in the northern portion of the National Petroleum Reserve-Alaska west of the Colville and Itkillik rivers with winter range sometimes extending south of the Brooks Range as far as Galena or the Seward Peninsula (Figure 3.3.4.1-1) (Kelleyhouse 2001; Prichard et al. 2001; BLM and MMS 2003). Animals from the TCH may occur as far east as the Arctic National Wildlife Refuge (ANWR). Studies have shown that the ranges of radio-collared caribou varied annually from 3,772 km^2 to 219,214 km^2 (Philo et al. 1993d), and also varied by season (Prichard et al. 2001). The Teshekpuk Lake area contains habitats that are used by TCH caribou year-round.

Estimates of the number of animals in the TCH were about 3,000 to 4,000 in 1978 to 1981(Davis and Valkenburg 1979; Cronin et al. 1998b) and 4,000 in 1982 (BLM pers. comm. 2003d). In 1984, the first photocensus of the TCH showed 11,822 caribou (Silva 1985). Other photocensus estimates in 1985 (13,406 caribou), 1989 (16,649 caribou), and 1993 (27,686 caribou) showed a steady increase in the TCH (Carroll 1992, 1995). This was followed by a decrease in the herd estimate in 1995 (25,076 caribou) (Carroll 1997). The herd then increased in 1999 (28,627 caribou) (Carroll 2003) and in 2002 (45,166 caribou) (Carroll pers. comm.). It is unlikely that the TCH actually increased from 28,000 to 45,000 between 1999 and 2002. It is more likely that the 1999, and possibly the 1995 censuses were underestimated due to unfavorable weather conditions (Carroll, pers. comm 2004). These censuses are summarized and compared to other arctic herds by several authors (Cronin et al. 1998b; Ballard et al. 2000; NRC 2003). The TCH has grown faster than the CAH over the last 30 years, and it has been suggested this is because of the impact of oilfield development on the CAH (NRC 2003). However, the PCH has recently declined without oilfields in its range (USGS 2002), indicating that factors such as population density, range condition, predation, immigration/emigration, and others can affect caribou numbers (Cronin et al. 1997, 1998b). These factors have not been quantified in the CAH and TCH so the reason for the different herd growth rates are not certain.

Migration

Most TCH caribou begin migrating from winter ranges across northwestern Alaska to the Teshekpuk Lake area during May and June. By early June most of the cows move into calving areas around the lake (Figure 3.3.4.1-2) (Carroll 1999a; Prichard et al. 2001). After calving, most TCH caribou move north of Teshekpuk Lake through the land corridor between the lake and the Kogru River on the east. They may also use the land area between the lake and Smith Bay on the west. Most of the herd uses areas along the coast for insect relief during mid-July to August, when TCH caribou spread out on all sides of the lake. Fall movements of the TCH occur after the insect season and are variable among individual caribou and years (Philo et al. 1993d; Whitten 1997; Carroll 2001; Prichard et al. 2001). Most TCH caribou winter on the coastal plain, and some winter in the Plan Area. However, in some winters some TCH caribou migrate far to the south of the coastal plain to Anaktuvuk Pass, the Seward Peninsula or other areas (Figure 3.3.4.1-4) (Prichard et al. 2001).

Calving Grounds

The calving grounds of the TCH are primarily in the northeast corner of the National Petroleum Reserve-Alaska near and around Teshekpuk Lake (Figure 3.3.4.1-2), including shoreline areas (Davis and Valkenburg 1979; Carroll 1992; Philo et al. 1993d; Kelleyhouse 2001; Prichard et al. 2001; BLM and MMS 1998a, 2003). If the snowmelt is in late spring, more caribou will calve south and west of the lake than if snowmelt is in early spring (Carroll 2001). Kelleyhouse (2001) reported that the size of the TCH annual calving grounds ranged between 2,431 km^2 and 4,820 km^2. The most concentrated calving areas ranged between 134 km^2 and 589 km^2. Recent calving by the TCH has been concentrated on the east side of Teshekpuk Lake (Figure 3.3.4.1-2) (BLM and MMS 1998a). Carroll (2001) reported that in 2000, calving occurred on all sides of Teshekpuk Lake and that more calves than usual were south and west of the lake. Aerial survey data (1999 to 2001) suggest that caribou use the entire area around Teshekpuk Lake, as well as the western part of the Plan Area during the calving period (Noel 1999; Noel 2000; Jensen and Noel 2002; Noel and George 2003).

Summer Distribution and Insect-Relief Areas

The Teshekpuk Lake area is important as summer range because of prevailing winds and proximity to the coast and river deltas that provide insect relief habitat with adjacent forage (BLM and MMS 1998a, 2003). On the Arctic Coastal Plain, caribou behavior and movements during summer are greatly influenced by harassment from mosquitoes and oestrid flies, forage availability, and weather (White et al. 1975; Dau 1986). During periods with little or no insect activity, summer distribution of caribou is related to the availability of easily digestible forage (White et al. 1975). Caribou tend to move to insect relief habitats, usually on the coast during warm periods with insect activity, and then move inland to foraging areas when insect activity decreases.

The TCH summer range is between Barrow and the Colville River (Figures 3.3.4.1-1) (BLM and MMS 1998a, 2003; Jensen and Noel 2002). In June and July, caribou are often located around the shore and islands of Teshekpuk Lake and in the area between Teshekpuk Lake and the Beaufort Sea from the Ikpikpuk River to the Kogru River. Many caribou also use summer habitats throughout the Plan Area (Jensen and Noel 2002) including the Colville Delta (Figures 3.3.4.1-3 and 3.3.4.1-4). These areas are used regularly by the TCH for insect relief and foraging (Carroll 1999a; Prichard et al. 2001). Additionally, small groups of caribou use the Pik Dunes (approximately 30 km south of Teshekpuk Lake) during insect harassment (Philo et al. 1993d). Other insect relief habitats in the summer ranges include sand dunes and ridges (BLM and MMS 1998a). The relatively narrow land areas on the east and west sides of the lake are travel corridors for caribou moving between habitats north and south of the lake (Prichard et al. 2001).

Fall and Winter Range Use And Distribution

Some caribou of the TCH occur year-round in the Teshekpuk Lake area (Davis and Valkenburg 1978; Prichard et al. 2001). During fall (August to September) many caribou have been observed around the lake and in the Plan Area as far east as Fish Creek (Prichard et al. 2001; Jensen and Noel 2002). Use of the Plan Area as winter range may include from 10 percent to 100 percent of the herd (BLM and MMS 1998a). During most years, TCH caribou winter on the North Slope coastal plain including the Plan Area, but some or all of the herd may also winter in other locations (Figure 3.3.4.1-5). In some years, some of the herd has migrated as far as the Seward Peninsula to the south (Carroll 1992; Philo et al. 1993d; BLM and MMS 2003; Prichard et al. 2001), Point Hope to the west, and the Dalton Highway north of Wiseman to the east (BLM and MMS 2003; Prichard et al. 2001). There is some overlap of the TCH and the WAH winter ranges (Carroll 1999a; BLM and MMS 1998a, 2003; Prichard et al. 2001).

Harvest and Predation

Subsistence harvesting of the TCH occurs from July through the winter by residents of all North Slope villages, including Atqasuk, Barrow, Point Hope, and Wainwright (Carroll 1999a; Prichard et al. 2001). Harvest by Nuiqsut and Anaktuvuk Pass residents also occurs from July through the winter if animals are present (PAI 2002a; Brower and Opie 1996, 1997). It is difficult to determine the numbers of TCH caribou harvested because not all hunters report their harvest and because most villages harvest caribou from more than one herd. However, village subsistence records and radiotelemetry data allow estimation of TCH harvest. During 1999 to 2000, approximately 2,500 TCH caribou were harvested, and during 2000 to 2001, approximately 2,760 TCH caribou were harvested by residents of North Slope villages (G. Carroll, pers. comm.). The numbers of TCH caribou harvested by sport hunters is generally small, and mostly in the Colville River drainage (Carroll 2001). The TCH has one of the highest harvest rates of the herds in Alaska.

Wolf predation of the TCH is not well-documented, but wolf densities on the North Slope coastal plain are low (BLM and MMS 1998a, 2003). The greatest harvests of wolves from the western North Slope (ADF&G Game Management Unit [GMU] 26A) have been near Nuiqsut and Anaktuvuk Pass (Carroll 2000a; Shideler 2000). Other predators of TCH caribou include grizzly bears, wolverines, and golden eagles (Murphy and Lawhead 2000). These species prey primarily on calves, but bears also kill adults. Data on bear, wolverine, and eagle predation of the TCH is not available, but is believed to be low.

CENTRAL ARCTIC HERD

Population Status and Range

The annual range of the CAH extends from the Colville Delta on the west to the Canning River on the east, and from the Beaufort Sea Coast on the north to the south slope of the Brooks Range (Figure 3.3.4.1-1) (Cameron and Whitten 1979; NRC 2003). During summer, CAH caribou occur on the coastal plain and some may occur west of the Colville River in the Plan Area and east of the Canning River in the Arctic National Wildlife Refuge. Calving occurs between the Colville and Canning rivers within 160 km of the Beaufort Sea (Cameron and Whitten 1979; USGS 2002; NRC 2003).

The CAH was estimated at approximately 5,000 caribou in 1975 and increased to approximately 23,444 in 1992 (Whitten and Cameron 1979; Cronin et al. 1998b; Lenart 1999b, 2003). The CAH declined to 18,093 in 1995 and then increased again to 19,730 in 1997 and 27,128 in 2000 (Lenart 1999b and unpublished data). The most recent photocensus conducted in 2002 documented approximately 32,000 caribou (Lenart 2003). The growth rate of the CAH was lower than that of the TCH and WAH, but higher than that of the PCH, over the last 30 years. These census data are summarized by several authors (Cronin et al. 1998b; 2000, 2001; NRC 2003; USGS 2002; Ballard et al. 2000).

The NRC (2003) concluded that the decline of the CAH between 1992 and 1995 likely resulted from low net calf production that was caused by synergistic negative impacts of summer insect harassment and displacement from oilfield habitats. The potential negative impact of the oilfields on caribou is also described by the USGS (2002). However, negative impacts of the oilfields, including the conclusion that oilfield impacts caused the CAH decline between 1992 and 1995, are equivocal because the CAH grew rapidly in other years. In addition, the TCH, without oilfields in its range, had a similar decline between 1993 and 1995 (NRC 2003) suggesting a potential common cause of declines in these herds on the North Slope. Other analyses showed that the decline of the CAH between 1992 and 1995 could be due to factors other than the affect of oilfields, including population density, immigration and emigration (Cronin et al. 1997; Cronin et al. 2000). The relative importance of natural factors such as winter and summer range conditions, population density, snow depth, insect harassment, predation, interherd movements, and anthropogenic (human-caused) factors associated with oil development on the dynamics of the CAH has not been determined (Cronin et al. 1997, 1998a, 1998b, 2000, 2001; Ballard et al. 2000; NRC 2003; USGS 2002; Murphy and Lawhead 2000).

Migration

CAH caribou migrate between winter ranges in the Brooks Range and summer ranges on the Arctic Coastal Plain (Cameron and Whitten 1979; Fancy et al. 1989). In general, pregnant cows arrive on the coastal plain between early May and early June, calving occurs between the last week of May and the second week of June, and bulls arrive by early July (Roby 1978; Whitten and Cameron 1980; Lawhead and Curatolo 1984; Jakimchuk et al. 1987). A gradual southward fall migration generally occurs after the insect season ends in mid-August (BLM and MMS 1998a, 2003).

Calving Grounds

The CAH calves between the Colville and Canning rivers to the east of the Plan Area. Calving usually occurs within 160 km of the Beaufort Sea, with concentrated areas east and west of the Sagavanirktok River (Cameron and Whitten 1979; USGS 2002; NRC 2003). One calving area includes a broad area east of the Sagavanirktok River, west of the Canning River, and south of Bullen Point. The other calving area is west of the Sagavanirktok River. Between 1993 to 2002 the greatest calving densities in this area west of the Sagavanirktok River were approximately 20 km south of the Kuparuk oilfield (Lawhead and Johnson 2000; Lawhead et al. 2003). Lower densities of calving occurred within and adjacent to the Kuparuk and Milne Point Oilfields during this time period. Calving has occurred in the oilfield areas since the oilfields were built in 1980 to 1981. However, the proportion of the herd calving in and near the oilfields has decreased since the mid-1980s (USGS 2002; NRC 2003; Noel et al. 2004). Although there is not a clear cause-and-effect relationship explaining the apparent shift in calving densities to the south, it could be due to avoidance of the oilfields (Murphy and Lawhead 2000; USGS 2002; NRC 2003). Alternatively, the change in calving density could be a result of a range expansion as the herd grew over the last 25 years, or other factors.

Summer Distribution and Insect-Relief Areas

The summer range of the CAH includes the area between the Canning and Colville rivers and between the Brooks Range and Beaufort Sea (Figure 3.3.4.1-1) (Smith 1996; Murphy and Lawhead 2000; NRC 2003). A combination of wind, weather, insects, and forage availability affect caribou distribution in summer. When harassed by insects, caribou of the CAH typically use coastal areas, river deltas and bars, and non-vegetated habitats such as gravel roads and pads for relief (White et al. 1975; Dau 1986; Pollard et al. 1996b; Noel et al. 1998). During periods of harassment by insects, large groups of caribou have been observed along the Beaufort Sea coastline, near Franklin Bluffs, on oilfield roads and gravel pads, and on the deltas of the Canning, Kadleroshilik, Kuparuk, Sagavanirktok, Shaviovik, and Staines rivers (Gavin 1983; Carruthers et al. 1984; Lawhead and Curatolo 1984; Pollard et al. 1996a, 1996b; Noel and Olson 1999a, 1999b; Olson and Noel 2000). Aerial surveys have documented CAH caribou moving west into the Colville River Delta in the Plan Area in the summer. The largest such documented movement (more than 10,000 caribou) occurred in the third week of July 2001 (Lawhead and Prichard 2002; PAI 2002a).

Winter Range Use and Distribution

Most CAH caribou move from the summer range on the coastal plain south to the Brooks Range (Figure 3.3.4.1-1) (Cameron and Whitten 1979; Lenart 1999b; BLM and MMS 2003). Radio-tracking flights during March 2001 and February 2002 located caribou north and south of the Brooks Range and east and west of the Dalton Highway/TAPS corridor (Lenart unpublished data). In many years, several hundred CAH caribou overwinter on the coastal plain, including areas within the Kuparuk and Prudhoe Bay oilfields. Fall and winter ranges of the CAH, may overlap with those of the TCH and WAH (Cronin et al. 1998b; Lenart 1999b; Prichard et al. 2001).

Harvest and Predation

Between 200 and 900 CAH caribou are harvested each year by local subsistence hunters from Nuiqsut and Kaktovik, and non-local hunters. Non-local subsistence and sport harvest is mostly along the Dalton Highway (Lenart 1999b; Murphy and Lawhead 2000). As noted for the TCH, wolf predation of the CAH is not well-documented, but wolf densities on the North Slope are low (Carroll 2000a; Shideler 2000). Other predators of CAH caribou include grizzly bears, wolverines, and golden eagles (Murphy and Lawhead 2000). Data on the extent of bear, wolverine, and eagle depredation of the CAH is not available.

PLAN AREA

The Plan Area is used by caribou from both the TCH and the CAH. The Colville River Delta is at the western edge of the CAH range and the eastern edge of the TCH range (Figure 3.3.4.1-1) (PAI 2002a: 4-73). In a study of the distribution of TCH caribou from 1990 to 1999, calving ranges were smallest, summer ranges intermediate, and winter ranges were largest in the Plan Area (Prichard et al. 2001). Telemetry data over the last 20 years indicate that caribou of the WAH rarely occur in the Colville River Delta, except as peripheral range for dispersing animals (PAI 2002a, Appendix B). PCH caribou may also use the Plan Area as peripheral range (BLM 2004b).

Calving Grounds

Telemetry and aerial survey data indicate that some TCH calving occurs in the western part of the Plan Area (Figures 3.3.4.1-2 and 3.3.4.1-3) (Burgess et al. 2003b; Noel 1999; Noel 2000), although most calving occurs to the west of the Plan Area (Figure 3.3.4.1-2) (BLM and MMS 2003; Jensen and Noel 2002). Satellite telemetry data indicate that from 1990 to 1999 TCH calving grounds were in the area surrounding Teshekpuk Lake and between Smith Bay and Harrison Bay, and most calving occurred north, northeast, and southeast of Teshekpuk Lake (Figure 3.3.4.1-2) (Prichard et al. 2001; BLM and MMS 2003). Additionally, Kelleyhouse (2001) summarized ADF&G radiotelemetry data from 1994 to 2000 and showed the calving grounds of the TCH included the western part of the Plan Area. Some concentrated calving occurs in the northwest part of the Plan Area (Figure 3.3.4.1-6). Most calving by the TCH in the Plan Area occurs in the area south of the Kogru River in the western part of the Plan Area (Figure 3.3.4.1-2) (BLM and MMS 2003). Calving surveys in the Northeast National Petroleum Reserve-Alaska (Noel 1999, 2000; Jensen and Noel 2002) recorded few caribou between the Kalikpik River and the Ublutuoch River compared to areas to the west. During these surveys, calving caribou were observed south of the Kogru River and between the Kogru River and Teshekpuk Lake. In the central portion of the Plan Area (approximately 950 km^2 in 2001 and 1,300 km^2 in 2002 in the vicinity of Fish and Judy creeks), Burgess et al. (2002b, 2003b) estimated moderate numbers of caribou (means of 564 and 958 for two surveys in the calving periods of 2001 and 2002, respectively; Figure 3.3.4.1-7). However, few calves were observed (means of 18 and 12 calves for two surveys in June 2001 and 2002, respectively) suggesting that the area is not heavily used by calving cows. Jensen and Noel (2002) also saw some calves in the Fish and Judy creeks area during the calving period in 2001.

Few caribou use the Colville River Delta during the calving period. Johnson et al. (1998) indicated that few adult caribou and almost no calves were observed on the Colville River Delta during calving surveys conducted in 1992 to 1993 and in 1995 to 1997. Low use of the Colville River Delta during the calving period could reflect avoidance of flooding during spring break-up (Whitten and Cameron 1983; PAI 2002a) or the low availability of tussock tundra, which is preferred by cow caribou during calving (Kuropat and Bryant 1980). The calving areas of the CAH are outside of the Plan Area to the east (Figure 3.3.4.1-1) (PAI 2002a, Appendix B; BLM and MMS 2003).

Summer Distribution and Insect-Relief Areas

Caribou from the TCH and the CAH use the Plan Area during the summer insect season, and use by the TCH predominates. The Plan Area is considered peripheral range for WAH and PCH caribou, which may be present during the summer (BLM 2004b).

Satellite telemetry data indicate that the area between Dease Inlet and Harrison Bay is used frequently by the TCH between early July and early August (Prichard et al. 2001; BLM and MMS 2003). During the mosquito season (late June and early July), use of this area by caribou was concentrated in the region between Smith Bay and Harrison Bay and from the north shore of Teshekpuk Lake to the Beaufort Sea Coast. This distribution included the northwest portion of the Plan Area around the Kalikpik and Kogru rivers and Fish Creek (Figure 3.3.4.1-8) (BLM and MMS 2003). These patterns were also seen with aerial surveys (Burgess et al. 2003b; Jensen and Noel 2002).

During the oestrid fly season (mid-July to mid-August), telemetry data showed that caribou were concentrated in the region between Dease Inlet and Teshekpuk Lake and on the east side of Teshekpuk Lake between the Beaufort Sea Coast and the area southeast of Teshekpuk Lake. This distribution includes the northwest portion of the Plan Area in the vicinity of the Kalikpik and Kogru rivers and Fish and Judy creeks (Figure 3.3.4.1-9) (Burgess et al. 2003b; Prichard et al. 2001; BLM and MMS 2003). During the oestrid fly season in the Plan Area, caribou may selectively use riparian areas (Burgess et al. 2003b).

Aerial surveys conducted through the insect seasons (late-June through August) showed variable numbers of caribou in the vicinity of Fish and Judy creeks in the Plan Area (estimated between 20 and 1,394 caribou in 2001 and between 0 and 540 caribou per survey in 2002 [Figure 3.3.4.1-7] [Burgess et al. 2002b, 2003b]). The area surveyed by Burgess et al. (2002b, 2003b) was inland from coastal insect-relief habitats, and the variability in caribou numbers could reflect different insect conditions on different survey days. In 2001, Jensen and Noel (2002) observed few caribou in the period between July 16 and August 7 in the western part of the Plan Area when weather conditions were favorable for parasitic insects. This suggests that caribou are likely to be present in greater numbers in the Plan Area during periods of cool weather when insect harassment abates. The combined survey data suggest that caribou were using insect-relief habitats outside of the Plan Area (Jenson and Noel 2002; Burgess et al. 2002b, 2003b). It is important to note that movements in and out of the Plan Area may be undetected during the limited time in which aerial surveys are done. Areas between Teshekpuk Lake and the Beaufort Sea Coast, along the edges and islands of Teshekpuk Lake, along the Beaufort Sea Coast from Dease Inlet to the Kogru River, and on sand dunes along the Ikpikpuk River and south of Teshekpuk Lake in the Pik Dunes region are potential insect-relief habitats for TCH caribou (Philo et al. 1993d; Carroll 1999a). It has been noted in literature and by local residents that TCH caribou will move into the Colville River Delta from the west under conditions of northeasterly winds, and during periods of intense insect harassment (Smith et al. 1994; PAI 2002a; Mark Wartes 2003**,** pers. comm.). When winds are still, TCH animals will remain in the vicinity of Fish Creek where ice lenses maintain cooler temperatures that provide insect relief (Mark Wartes 2003**,** pers. comm.).

The Colville River Delta is used most heavily by caribou during July when mosquitoes and oestrid flies are active. Thousands of caribou, particularly from the CAH, could use the Plan Area at this time (Johnson et al. 1997; PAI 2002a). Large groups of CAH caribou moved into a westerly wind across the Colville River and into the vicinity of Fish and Judy creeks in late July 2001. During this time at least 10,700 caribou moved west from the Kuparuk River onto the Colville River Delta during a period of warm temperatures and persistent westerly winds (Burgess et al. 2002b; Lawhead and Prichard 2002). Many caribou continued west into the National Petroleum Reserve-Alaska, including approximately 6,000 caribou that moved upstream along Fish Creek on July 23, 2001 (Del Vecchio, pers. comm. cited in Burgess et al. 2002b). Aerial surveys later that same day found only 636 caribou remaining in the vicinity of Fish Creek (Burgess et al. 2002b).

It has been noted that the CD-4 vicinity is less likely to be used for mosquito-relief habitat than the more coastal CD-3 area, but the CD-4 area could be used by caribou when insect harassment abates. A local resident noted that the movement of thousands of CAH caribou into the Plan Area in 2001 included traversing the area between the CD-2 and CD-4 sites. This might not be an annual occurrence, but when the CAH moves westward from the Colville River this is the usual crossing area.

Fall and Winter Range Use and Distribution

Distribution (including rutting areas in the fall) of the TCH are annually variable and dispersed east, west and south from summer ranges. Fall ranges include the Plan Area, particularly in the vicinity of Fish and Judy creeks, as observed in 2002 (Burgess et al. 2003b). In mid- to late October of 2001 and 2002, densities of caribou were high in the Plan Area relative to those observed during aerial surveys at other times in the same years (Figure 3.3.4.1-7) (Burgess et al. 2003b). Satellite telemetry data from 2002 indicated that most collared TCH caribou were south and southeast of Teshekpuk Lake during the October rut (Carroll pers. comm. cited by Burgess et al. 2003b). Satellite telemetry data from 1990 to 2001 also indicated there was little use of the Plan Area by TCH caribou during October (Prichard et al. 2001; BLM and MMS 2003). The CAH is not known to use the Plan Area during the fall.

Winter range use by TCH caribou varies within and between years, but could include portions of the Plan Area, particularly the northwest and southeast portions (Figure 3.3.4.1-5) (BLM and MMS 2003). Approximately 1,200 (1.26 caribou per km^2) and 800 (0.61 caribou per km^2) caribou were estimated within approximately 1,000 km^2 centered in the Fish-Judy Creek area during mid-May of 2001 and 2002, respectively (Burgess et al. 2002b, 2003b). Mean group sizes were approximately 5.8 caribou in 2001 and 3.2 caribou in 2002, and no calves were present. These caribou likely overwintered in the area (Burgess et al. 2002b). The CAH is not known to use the Plan Area during the winter.

Harvest and Predation

Nuiqsut residents harvest caribou year-round, depending on availability (BLM and MMS 1998a), although most caribou are harvested between mid summer and early winter (July to October) (Prichard et al. 2001). The entire Plan Area falls within defined subsistence land use for caribou harvest (BLM and MMS 1998a). Nuiqsut residents gain access to areas that provide a substantial proportion of their annual harvest via the Colville River Delta and Fish Creek (BLM and MMS 1998a). Approximately 65 percent of 513 caribou harvested by Nuiqsut residents in 1985, of 278 caribou harvested in 1992, 672 caribou harvested in 1993, and 258 caribou harvested in 1994 to 1995 were taken in the Colville River Delta, along Fish and Judy creeks (Figure 3.4.3.2-7), giving an approximate annual harvest in the range of 168 to 468 caribou from the Plan Area.

MUSKOXEN

NORTH SLOPE

Historically, muskoxen occurred in many areas of northern Alaska, but they were extirpated from the Arctic Coastal Plain in the mid-1800s (Hone 1934). Muskoxen were reestablished by translocation of animals from Greenland to Nunivak Island near the western Alaska coast in 1935 and 1936 (Spencer and Lensink 1970). Sixty-four muskoxen from Nunivak Island were subsequently moved to Barter Island and the Kavik River near the ANWR in 1969–1970 (Jingfors and Klein 1982; BLM and MMS 2003). Thereafter, muskox numbers in northeastern Alaska increased, and their range expanded to the Colville River on the west and beyond the Babbage River on the east (Reynolds 1998; BLM and MMS 2003). Reynolds (1998) described three stages of muskox population change on the Arctic Coastal Plain: (1) slow growth for a few years immediately following the release, (2) a phase of rapid growth for approximately a decade, and (3) decline and stabilization in regions first occupied, concurrent with emigration of mixed-sex groups and expansion into additional regions during the second decade. Currently, the muskox population appears to be stable with approximately 672 muskoxen in the North Slope of Alaska and northwestern Canada (Lenart 1999a; Reynolds et al. 2002). Reynolds et al. (2002) noted that a decline in the rate of population growth in ANWR was probably caused by declines in survival and calf production.

Muskoxen occur on the Arctic Coastal Plain year-round and use habitats along river corridors, floodplains, and foothills in all seasons (Reynolds et al. 2002). Summer and winter surveys have shown that riparian corridors and adjacent upland habitats are important to muskoxen (Reynolds et al. 2002; BLM and MMS 2003). Muskox eat mainly sedges in winter and willow leaves, sedges, grasses, and forbs in summer (Klein 2000). During winter, muskoxen usually form larger groups of 6 to 60 animals and remain in one location for longer time periods. During summer, smaller groups of 5 to 20 animals are more common and they move more frequently than in winter (Lenart 1999a). Reynolds et al. (2002) reported that the average size of core areas used by muskoxen in the ANWR in summer (223 km^2) were significantly larger than core areas used during winter and the calving season (27 to 70 km^2). Grizzly bears kill calf and adult muskoxen, and predation by bears has increased in recent years in both the ANWR and the Colville River drainage near the Plan Area (Reynolds et al. 2002a, 2002b; O'Harra 2003). There has been no state-sanctioned sport harvest of muskoxen in GMU 26A (Hicks 1999).

PLAN AREA

Muskoxen expanded their range westward into the National Petroleum Reserve-Alaska from the area of reintroduction in the ANWR (Reynolds 1998; Reynolds et al. 2002). Recently, small numbers of muskoxen have occasionally been observed west of the Colville River (Lenart 1999a). Lawhead and Johnson (2000) observed muskoxen in the Kuparuk and Colville rivers region and reported that most sightings were recorded on the Kuparuk River floodplain. Other sightings were near the Itkillik River and uplands. During surveys in the Fish-Judy Creeks Facility Group, Burgess et al. (2002, 2003) recorded one small group of five or six adult muskoxen in 2001 and none in 2002. Johnson et al. (1999) and PAI (2002) summarized muskoxen sightings from 1992 to 1993 and 1995 to 2001 in the Colville River Delta and Kuparuk area. Most sightings were on the east side of the Delta north of the Alpine pipeline and along the Kachemach, Itkillik, and Kuparuk rivers and uplands (Figure 3.3.4.1-10). In 1995 and 1996, muskoxen were seen between the Colville River and the Dalton Highway, and in 2001 several breeding groups were seen along the Colville River and Fish Creek (BLM and MMS 2003). Muskoxen are not abundant in the Plan Area, but they might continue to expand westward into the Plan Area.

MOOSE

NORTH SLOPE

Moose occur at low densities on the Arctic Coastal Plain, which is the northern limit of moose range in Alaska. Habitat limits the size of the moose population in this area (Carroll 2000b). Moose are widely distributed during the summer, ranging from the northern foothills of the Brooks Range to the Arctic Coast. As snow accumulates during fall, moose move to riparian corridors of large river systems, where they concentrate in winter. The largest winter concentrations of moose occur in the inland portions of the Colville River drainage (Carroll 2000b). As snow cover in the foothills decreases in April, moose begin to move away from winter concentration areas but generally remain in riparian areas.

Late winter surveys conducted in concentration areas in the western North Slope and Brooks Range (GMU 26A) in 1970, 1977, 1984, 1991, 1995, 1999, and 2002 documented 1,219, 1,258, 1,447, 1,535, 757, 326, and 576 moose, respectively (BLM and MMS 2003; Carroll 2000b). It appears that poor nutrition, disease, predation, and hunting are important influences on North Slope moose population (Carroll 2000b). Trends during 1997 to 2002 indicated that the moose population has been increasing in recent years. Low adult mortality and high calf survival have contributed to this population increase (Carroll 2000b). This increase followed a decline of more than 50 percent between 1991 and 1997 (Carroll 2000b; BLM and MMS 2003). Because of low population densities, in 1996 GMU 26A was closed to moose hunting, except for the portion of the Colville River downstream of the Anaktuvuk River (Carroll 2000). For at least 4 years, all legal harvest was to occur in August without use of aircraft. During that time, all successful and most unsuccessful hunters were local residents reporting 6 to 20 moose-kills per year (Carroll 2000b). In 2002, moose hunting regulations were changed to include an annual harvest of one bull per hunter for only Alaska residents in GMU 26A.

PLAN AREA

Within the Plan Area, moose use primarily riparian habitats in the Colville River Delta and have occurred at densities of 0.25 to 1.0 moose per square mile (Figure 3.3.4.1-10) (BLM and MMS 1998a, 2003). Johnson et al. (1999) reported that moose were rare on the Colville River Delta in summer. No moose were observed from 1992 to 1996, two moose were observed in 1997, and one moose was observed in 1998. An adult female and young male moose were present at the Colville Village site on July 17, 2001 (T. Helmericks 2004, pers. comm.). Moose occur at higher densities upstream of the Plan Area along the Colville River (BLM and MMS 1998a, 2003), which is primarily where Nuiqsut residents hunt them.

GRIZZLY BEAR (BROWN BEAR)

NORTH SLOPE

The coastal plain is the northern limit of grizzly bear range in North America. It is considered marginal habitat because of the severe climate, short growing season, and limited food resources (Shideler and Hechtel 2000). There are relatively low densities of grizzly bears (0.5 to 2.0 bears per 1,000 km^2) on the coastal plain, including habitats in the Prudhoe Bay and Kuparuk oilfield region. Densities of grizzly bears are greater in the mountains and foothills of the

Brooks Range in areas such as the Itkillik Hills and Franklin Bluffs and along riparian corridors (Reynolds 1979; Young and McCabe 1998; Shideler and Hechtel 2000; Carroll 1998b; BLM and MMS 2003; Shideler 2003, pers. comm.). Recent estimates suggest that 60 to 80 bears use the region between the Colville and Canning rivers (Shideler and Hechtel 2000; Shideler 2003, pers. comm.). Because of the presence of permafrost, grizzly bear dens on the coastal plain are usually restricted to well-drained sites such as pingos, riverbanks, and sand dunes. These sites are often with a southwest aspect in the lee of prevailing winds where snow tends to accumulate the most in winter. Dens are typically used once (Shideler and Hechtel 2000). Since 1996 the grizzly bear harvest in the western North Slope and Brooks Range has remained well below the management objectives of 31 bears per year in GMU 26A and 20 bears per year in GMU 26A West (Carroll 1999b). Most reported takes are by nonresident sport hunters. Residents of Nuiqsut harvested 10 grizzly bears in 1985, three in 1992, 10 in 1993, and none in 1994 to 1995 (ADFG CPDB; Fuller and George 1999; Brower and Opie 1998). These numbers represent the subsistence harvest for all grizzly bears taken by residents of the village. An unknown number of these bears were taken in the Plan Area.

PLAN AREA

Twenty-five marked grizzly bears and their dens have been found in the Colville River Delta, the Fish Creek/Judy Creek area, other riparian areas in the Plan Area, and the Colville-Kuparuk region (Figure 3.3.4.1-11) (PAI 2002a; ADFG unpublished data 2003). In general, the entire Colville River Delta is potential denning habitat for grizzly bears (PAI 2002a; BLM and MMS 2003). However, more dens have been found southeast of the Delta in the upper reaches of the Kachemach and Miluveach river drainages than on the Delta itself (Johnson et al. 1999). In and near the Plan Area, recent observations indicate that riparian areas are used frequently by grizzly bears, and more than ten dens of marked bears have been found in such habitats (Shideler 2004, pers. comm.). In the Northeast National Petroleum Reserve-Alaska, grizzly bears and dens have been observed incidentally during surveys for caribou and fox dens (Noel 1999; Noel 2000; Burgess et al. 2002b; Jensen and Noel 2002; Burgess et al. 2003b). Within the vicinity of Fish and Judy creeks in 2001, Burgess et al. (2002b) recorded seven observations of grizzly bears and documented three dens, and in 2002 Burgess et al. (2003b) documented two observations of grizzly bears and three more dens (Figure 3.3.4.1-10). Additionally, in summer 2001, during six full-coverage aerial surveys north of Fish Creek within the National Petroleum Reserve-Alaska Plan Area, Jensen and Noel (2002) observed five grizzly bears on or adjacent to the Kalikpik River, northwest of the confluence of Judy and Fish creeks, approximately 3.5 miles south of the Kogru River mouth, and south of Harrison Bay in the vicinity of the Kalikpik and Kogru rivers (Figure 3.3.4.1-10). In general, the Plan Area and adjacent northeastern National Petroleum Reserve-Alaska appear to be better grizzly bear habitat, with proportionally more well-drained potential denning habitat and ground squirrel habitat, than areas of the coastal plain east of the Colville River (Shideler 2004, pers. comm.).

GRAY WOLF

NORTH SLOPE

Wolf numbers on the Arctic Coastal Plain and Brooks Range (GMU 26) have fluctuated since the 1900s in response to changes in prey populations (caribou and moose), a federal wolf control program in the 1950s, and aerial and snowmobile hunting by the public since the 1960s (Carroll 2000a; Shideler 2000). After prohibitions of aerial wolf hunting in 1970 and land-and-shoot hunting in 1982, the wolf population increased, especially in the mountains and foothills of the Brooks Range. In general, wolves are more abundant in the Brooks Range than on the Arctic Coastal Plain. This could be because of better prey availability and denning habitat in the Brooks Range, and rabies outbreaks and hunting pressure on the coastal plain (BLM and MMS 2003). In 1982, the wolf population in the western North Slope and Brooks Range (GMU 26A) was estimated at 144 to 310 animals (Carroll 2000a). In 1993, the population estimate increased to 240 to 390 wolves in 32 to 53 packs (Carroll 2000a).

The highest wolf densities in the National Petroleum Reserve-Alaska are along the Colville River. Surveys near Umiat showed that the density of wolves increased from 2.6 wolves per 1,000 km^2 in 1987 to 4.1 wolves per 1,000 km^2 in 1994 (Bente 1998). A survey in 1998 estimated 1.6 wolves per 1,000 km^2 and indicated that a substantial decline had occurred since 1994 (Bente 1998). This decline might have been related to the decrease in the moose population, which declined by 75 percent between 1992 and 1996 (BLM and MMS 2003).

The subsistence harvest of wolves is greatest in the southeastern portion of GMU 26A, where residents of Anaktuvuk Pass and Nuiqsut hunt and trap wolves throughout the winter (Carroll 2000a). The annual subsistence harvest throughout GMU 26A has ranged from approximately 50 to 120 wolves (Carroll 2000a).

PLAN AREA

There are no data for wolves specifically for the Plan Area, but they are believed to be uncommon (Table 3.3.4-1) (PAI 2002a). A wolf pack was observed occasionally during seismic exploration in the northwestern portion of the Plan Area in late winter 2003.

WOLVERINE

NORTH SLOPE

Wolverines occur throughout the Arctic Coastal Plain but are more common in the mountains and foothills of the Brooks Range (Bee and Hall 1956; BLM and MMS 1998a, 2003). Magoun (1984) estimated a fall population size of 821 wolverines for the western North Slope (GMU 26A), based on a density of 1 wolverine per 54 square miles (mi$^{2)}$. Wolverines require large territories and have a low reproductive rate. They use a broad range of habitats, frequently occurring in tussock meadow, riparian willow, and alpine tundra habitats (BLM and MMS 1998a, 2003). The stomach contents of wolverines harvested from the National Petroleum Reserve-Alaska included caribou, ground squirrels, ptarmigan, and eggshells (Magoun 1979; BLM and MMS 1998a, 2003). Wolverines may kill prey or scavenge carrion, so this does not necessarily reflect predation by wolverines. From 1991 to 1994, 2 to 14 wolverines were harvested in GMU 26A; however, it is likely that more animals are harvested and not reported (Carroll 2000b). Most harvest of wolverines is by residents of the North Slope.

PLAN AREA

Wolverines are uncommon in the Plan Area, having been observed rarely in the northeast National Petroleum Reserve-Alaska, on the Colville River Delta, and east to the Kuparuk River during extensive wildlife surveys in that region from 1992 through 2002 (Figure 3.3.4.1-10) (Smith et al. 1993; Johnson et al. 1999; PAI 2002a; Burgess et al. 2002b; PAI 2002a; BLM and MMS 2003). Adult wolverines were observed along the Tamayagiaq Channel in June 1993 (Smith et al. 1994), near the mouth of the Kachemach River in June 1998 (Johnson et al. 1999), south of Fish Creek in September 2001 (Burgess et al. 2002b), and south of the Ublutuoch River in October 2002 (Burgess et al. 2003b). Additionally, two wolverines were observed adjacent to Fish and Judy creeks in April to July 1977 and 1978 (Figure 3.3.4.1-10) (BLM and MMS 1998a)

ARCTIC FOX

NORTH SLOPE

The arctic fox is the most common furbearer on the Colville River Delta and adjacent coastal plain. Population estimates are not available for arctic foxes on the western North Slope (Carroll 1995). However, arctic fox populations fluctuate in response to prey population cycles (Macpherson 1969; Chesemore 1975), and populations may be larger where human garbage provides food (Burgess, 2000). Lemmings and voles are important prey year-round for arctic foxes. Foxes also forage on carcasses of caribou and marine mammals. During summer, nesting birds, eggs, and ground squirrels are important prey for arctic foxes (Chesemore 1968; Garrott et al. 1983). Rabies is common in arctic foxes on the North Slope and could be a source of mortality (Ballard et al. 2001, and references therein). Adult foxes excavate dens on raised landforms with well-drained soils, including riverbanks, mounds, pingos, ridges, dunes, and shorelines. Dens could be used during the summer breeding season for many years. Pups are born in early summer and are fed by the male and female. The pups begin to hunt on their own at approximately 3 months, and family units gradually disband and disperse in September and October. During winter, some arctic foxes move out onto the sea ice where they scavenge on the remains of polar bear kills. Arctic foxes are generally solitary during winter, although they sometimes congregate at food sources such as carcasses or garbage. Harvest data for the arctic fox are not available, but low fur prices in the mid-1990s resulted in relatively few foxes being trapped (Carroll 1998).

PLAN AREA

Arctic foxes prefer riparian or upland shrub habitats for denning; however, these habitats are rare on the Colville River Delta (Burgess et al. 2002b; Johnson et al. 2002; PAI 2002a). To date, 17 arctic fox dens have been documented on the Colville River Delta from surveys conducted in 1992 to 1993 and 1995 to 2002 (Figure 3.3.4.1-12) (Burgess et al. 2002b; Johnson et al. 2002; PAI 2002a). Total density (occupied and unoccupied) and occupied den densities on the Colville River Delta in 2001 were estimated to be one den per 12.5 mi^2 and one occupied den per 35.5 mi^2, respectively. Burgess et al. (2002b, 2003b) documented a total of 34 arctic fox dens (one den per 7.8 mi^2) in the Fish-Judy Creeks Facility Group in 2001 to 2002 (Table 3.3.4-2 and Figure 3.3.4.1-12). Eberhardt et al. (1983) reported one den per 13.1 mi^2 for a study area of 656 mi^2 in the Colville region. Densities reported for the Prudhoe Bay oilfield region ranged from one den per 4.6 mi^2 to one den per 5.8 mi^2 (Eberhardt et al. 1983; Burgess et al. 1993; Rodrigues et al. 1994; Ballard et al. 2000).

RED FOX

NORTH SLOPE

No quantitative population information is available for red foxes on the western North Slope (Carroll 1995), but the species is considerably less common than arctic foxes. Red foxes are mainly found in the mountains and foothills of the Brooks Range. On the coastal plain, they are found mostly along major rivers. Important prey species and denning habitat requirements for red foxes are similar to those of arctic foxes, as described above. Red foxes are generally aggressive toward arctic foxes and could displace them. Harvest data for red foxes is not available, but low fur prices in the mid-1990s resulted in relatively few foxes being trapped (Carroll 1998).

PLAN AREA

In recent years, four to six red fox dens have been used annually on the Colville River Delta (Figure 3.3.4.1-12) (Johnson et al. 2003a); all of these dens were located in sand dunes in riverine or upland shrub habitats. In the vicinity of Fish and Judy creeks, Burgess et al. (2002b, 2003b) reported a single red fox den on a sand dune bordering Fish Creek. This den was unoccupied in 2001 and 2002 (Table 3.3.4-2 and Figure 3.3.4.1-12).

SMALL MAMMALS

NORTH SLOPE

Small mammals that could be found in the Plan Area include arctic ground squirrel, ermine (short-tailed weasel), least weasel, tundra hare (or Alaskan hare), snowshoe hare, two species of lemming, three species of vole, and two species of shrew (Table 3.3.4-1) (BLM and MMS 2003; PAI 2002a). Small mammals are important prey for grizzly bears, foxes, wolves, wolverines, and birds of prey. Many small mammals undergo cyclic population fluctuations. Arctic ground squirrels are widely distributed and dig burrow complexes in well-drained soils on stream banks, dunes, and pingos where they hibernate during winter. The tundra hare occurs in western coastal Alaska from the Alaska Peninsula north to the Kotzebue region, but its occurrence on the North Slope has not been verified in many years (Bee and Hall 1956; Best and Henry 1994; Klein 1995). It probably does not occur in the Colville River region because its range has contracted (Klein 1995). In the mid-1990s, the population of snowshoe hares increased in the central Colville River drainage (ARCO et al. 1997). In June 1997, two snowshoe hares were seen on the Colville River Delta (Johnson et al. 1998). Lemmings are known for wide fluctuations in population numbers. Brown lemmings peak in abundance in the Barrow region at intervals averaging 3 to 5 years (ADF&G 1994; BLM and MMS 2003), but lemming cycles appear to be less frequent on the coastal plain along the central Beaufort Sea Coast (Feist 1975). Lemmings, voles, and shrews are active throughout the year and are important food for predators.

TABLE 3.3.4-2 LANDFORMS, ACTIVITY STATUS, AND NUMBER OF PUPS COUNTED AT ARCTIC AND RED FOX DEN SITES IN THE NATIONAL PETROLEUM RESERVE-ALASKA STUDY AREA, ALASKA, 2001-2002

Site No.	Landform	2002 Status	2002 Pup Count	2001 Status	2001 Pup Count
Arctic Fox					
200	DLB bank	inactive	unknown	inactive	unknown
201	DLB bank	inactive	unknown	inactive	unknown
202	lake bank	active	0	natal	2
203	low ridge	inactive	unknown	inactive	unknown
204	lake bank	active	0	inactive	unknown
205	river bank	inactive	unknown	inactive	unknown
206	stream bank	active	0	inactive	unknown
207	DLB bank	inactive	unknown	inactive	unknown
208	lake bank	active	0	natal	≥2
209	low mound	inactive	unknown	inactive	0
210	Pingo	inactive	unknown	inactive	unknown
211	lake bank	active	0	inactive	unknown
212	lake bank	inactive	unknown	inactive	unknown
213	lake bank	inactive	unknown	inactive	unknown
214	DLB bank	inactive	unknown	inactive	unknown
215	lake bank	inactive	0	natal	5
216	stream bank	active	0	inactive	0
218	low ridge	inactive	unknown	inactive	0
219	DLB bank	inactive	unknown	inactive	unknown
220	low ridge	inactive	unknown	active	0
221	low ridge	active	0	inactive	unknown
222	DLB bank	inactive	unknown	active	0
223	lake bank	natal	≥1 (dead)	inactive	unknown
225	DLB bank	inactive	unknown	unknown	unknown
226	low mound	inactive	unknown	unknown	unknown
227	low mound	inactive	unknown	unknown	unknown
228	DLB bank	inactive	unknown	unknown	unknown
229	lake bank	active	0	unknown	unknown
230	old beach ridge	inactive	0	unknown	unknown
231	stream bank	inactive	unknown	unknown	unknown
232	low ridge	inactive	unknown	unknown	unknown
233	lake bank	inactive	unknown	unknown	unknown
234	sand dune	inactive	unknown	unknown	unknown
235	stream terrace	inactive	unknown	unknown	unknown
Red Fox					
217	sand dune	inactive	unknown	inactive	unknown

Notes:
DLB – drained-lake basin
Zero (0) indicates that den was observed but no pups were seen

PLAN AREA

There are few data for small mammal numbers or distribution in the Plan Area but all species are probably present in the Plan Area to some extent (Table 3.3.4-1).

3.3.4.2 Marine Mammals

Most of the species of marine mammals that occur regularly in the Beaufort Sea offshore from the Plan Area have holarctic distributions that include multiple geographic stocks. Species inhabiting the Beaufort Sea include ringed seal, spotted (or largha) seal, bearded seal, polar bear, bowhead whale, and beluga (or belukha) whale. Table 3.3.4-3 lists the marine mammal species of the Beaufort Sea including their status under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Ringed seals, bearded seals, and polar bears are present year-round and move extensively throughout the Beaufort Sea region. Bowhead and beluga whales are normally present from April to October, and spotted seals are present from July through mid-October. Bowhead whales, bearded seals, ringed seals, and polar bears are important subsistence species for hunters from Barrow, Nuiqsut, and Kaktovik. Inupiat hunters take beluga whales sporadically when they are available.

TABLE 3.3.4-3 MARINE MAMMAL SPECIES OF THE BEAUFORT SEA INCLUDING COMMON AND SCIENTIFIC NAME, ABUNDANCE AND RESIDENCY CLASSIFICATION, AND STATUS UNDER THE MMPA AND ESA

Common Name	Scientific Name	INUPIAQ Name	Abundance[a]	Seasonal Residency	Status under MMPA[b]	Status under ESA
Ringed seal	*Phoca hispida*	qayabulik, natchiq	abundant	year-round	protected	Not listed
Spotted (Largha) seal	*Phoca largha*	qasigiaq	common	seasonal	protected	Not listed
Bearded seal	*Erignathus barbatus*	ugruk	abundant	year-round	protected	Not listed
Ribbon seal	*Phoca fasciata*		occasional	seasonal	protected	Not listed
Polar bear	*Ursus maritimus*	nanuq	abundant	year-round	protected	Not listed
Beluga (Belukha, white) whale	*Delphinapterus leucas*	qixalugaq, sisuaq	abundant	seasonal	protected	Not listed
Bowhead whale	*Balaena mysticetus*	abviq	abundant	seasonal	depleted	Endangered
Gray whale	*Eschrichtius robustus*		occasional	seasonal	protected	Delisted
Killer whale	*Orcinus orca*		occasional	seasonal	protected	Not listed
Pacific walrus	*Odobenus rosmarus*	aiviq	occasional / rare	seasonal	protected	Not listed
Narwhal	*Monodon monoceros*	qixalugaq tuugaalik	rare	unknown	protected	Not listed

Notes:

[a] Modified from Morris et al. (1983) and Calkins (1986).

[b] Marine Mammal Protection Act. Endangered species are classified automatically as depleted; all stocks of depleted species are strategic stocks.

Other marine mammal species that occasionally occur in the Beaufort Sea include gray whale, killer whale, harbor porpoise, and ribbon seal. These species reach the northern limits of their summer distributions in the northeastern Chukchi Sea, and their occurrence in the Beaufort Sea is in low numbers and irregular. Walrus occur regularly in the western Beaufort Sea, but decrease markedly to the east, being found mainly as individual stragglers east of Pitt Point (Burns et al. 2001). These species will not be considered further.

No marine mammals that occur in the Beaufort Sea are listed by the BLM as Species of Concern in Alaska. The bowhead whale is listed as depleted under the MMPA and as endangered under the ESA and is discussed in Section 3.3.5, Endangered and Threatened Species.

RINGED SEAL

Ringed seals are the smallest and most abundant of the arctic ice seals (Kingsley 1986; Smith and Hammill 1981). Ringed seals have a circumpolar distribution, occurring in all areas of the Arctic Ocean, and range from approximately 35°N to the North Pole (Kingsley 1986). The Alaska stock of ringed seals occurs in the Bering, Chukchi, and Beaufort seas. The size of the Alaska population is not currently known (Anglis and Lodge 2002), but estimates range from 1 million to 3.5 million individuals (Frost et al. 1988). The Beaufort Sea population could range from 80,000 in the summer to 40,000 in the winter (Frost and Lowry 1981).

NORTH SLOPE

Densities of ringed seals in the Alaska nearshore Beaufort Sea averaged 0.93 seals per km^2 and were higher to the east of Flaxman Island (1.19 seals per km^2) than to the west of Flaxman Island (0.81 seals per km^2) (Bengtson et al. 2000). These estimates are not corrected for the number of seals that are not visible to observers because they were underwater or in lairs under the snow[CHECK REF].

Densities of ringed seals near Prudhoe Bay between 1997 and 2002 ranged from 0.39 to 0.72 seals per km^2 (Moulton et al. 2003). These are lower than densities calculated in the same area during the 1980s. The differences could be due, in part, to differences in the timing of surveys, the timing of lair abandonment (Kelly et al. 2002a, 2002b), or a decrease in the abundance of seals since the 1980s. Seal densities reported for other areas of the Beaufort Sea range from 0.233 to 2.580 seals per km^2 (summarized in Stirling and Øritsland 1995).

The preferred breeding habitat for ringed seals is thought to be thick, consolidated landfast ice, but several studies have also identified breeding populations on drifting pack ice (Finley et al. 1983; Wiig et al. 1999). It is not known whether ringed seals breed in pack ice in the Beaufort Sea. Ringed seals begin using a series of breathing holes in the ice as soon as ice begins to form in autumn, and they maintain some holes through the winter (Smith and Stirling 1975). Lairs are excavated beneath the snow adjacent to some breathing holes in areas where ice topography creates snowdrifts at least 20 centimeters (cm) thick (Smith and Stirling 1975). Pregnant females give birth to pups within some of these lairs in late March through April. Ringed seals that breed in the pack ice could move to the shorefast ice after the breeding season (Smith and Lydersen 1991), and aerial counts of seals basking on landfast ice in spring (especially in areas near the ice edge and along cracks) might not accurately reflect the number of seals that use the nearshore environment through the winter.

Ringed seals are an important subsistence resource for the Inupiat of Alaska’s North Slope. The number of seals harvested by Alaskan Inupiat was between 7,000 and 15,000 animals per year from 1962 to 1972 and declined to 3,000 in the 1980s (Kelly 1988). There is currently no reliable estimate of the total number of ringed seals harvested by Alaska Natives for subsistence use.

PLAN AREA

The density of ringed seals near the Plan Area probably depends on a variety of factors including food availability, water depth, ice stability, and ice topography. There have been no studies of ringed seals in Harrison Bay or the Plan Area specifically. However, ringed seals would be expected in areas with water depths greater than 3 meters (Moulton et al. 2002).

SPOTTED (LARGHA) SEAL

Spotted seals are medium-sized pinnipeds that range along the continental shelf from the central Beaufort Sea through the Chukchi, Bering, and Okhotsk seas to the Sea of Japan. The Alaska stock of spotted seals occurs from the Bering Sea to the Beaufort Sea in the Arctic Ocean. There is no reliable estimate of the numbers of spotted seals in Alaska (Rugh et al. 1995; Angliss and Lodge 2002). However, estimates of the worldwide population ranged from 335,000 to 450,000 seals, with 200,000 to 250,000 spotted seals in the Bering Sea, including Russian waters (Burns 1973). There are no reliable data from which to determine population trends, but the population of spotted seals in Kasegaluk Lagoon in the northeast Chukchi Sea appears to have been stable from at least the late 1970s to the early 1990s (Frost et al. 1993).

NORTH SLOPE AND WINTERING AREAS

Spotted seals are not common in the Beaufort Sea and are present only during the ice-free summer season. Spotted seals haul out on barrier islands, beaches, and sand bars on river deltas but do not follow the receding pack ice edge. Spotted seals migrate west and south from the Beaufort and Chukchi seas in October and pass through the Bering Strait in November (Lowry et al. 1998). Spotted seals overwinter in the Bering Sea along the ice edge and make east-west movements along the ice edge (Lowry et al. 1998). Spotted seals in the Alaska Bering Sea preferred nearshore areas from September to December, offshore habitat in January and February, and pack ice during March and April (Lowry et al. 2000). Spotted seals give birth in March or April on the Bering Sea pack ice and mate approximately 1 month after giving birth (Seaman et al. 1981).

Spotted seals feed on a variety of fishes and pelagic crustaceans; composition of the diet varies by season and location. During winter, fishes such as pollock and capelin at the ice front dominate the diet. During spring and summer, young animals prey on smaller fishes and crustaceans, while adults consume larger fishes, crustaceans, squid, and octopus (Lowry 1985).

Spotted seals are an important subsistence resource for Alaska Natives, particularly in the Yukon-Kuskokwim and Bering Strait regions, although they are less important to the Inupiat on the North Slope.

PLAN AREA

Spotted seals regularly haul out in the main (east) channel of the Colville River, and some also are seen in the Nigliq Channel and in the Fish Creek Delta. The Colville River Delta is now the easternmost concentration area for spotted seals in the Alaskan Beaufort Sea (Seaman et al. 1981). Spotted seals have been observed in the Colville River as far upstream as Ocean Point and occur regularly as far as the mouth of the Itkillik River (Reed 1956; Seaman et al. 1981). Historically, as many as 400 spotted seals were estimated to have used the Colville River and the Sagavanirktok River deltas in the 1960s, although the number fell to 150 to 200 in the 1970s, after the village of Nuiqsut was reestablished (Seaman et al. 1981). In 1996 and 1998, as many as 24 spotted seals were seen at haulouts in the main channel of the Colville River Delta (Johnson et al. 1997, 1999; PAI 2002a). In September 2002, at least 30 spotted seals were seen at these same haulouts (ABR, unpublished data).

BEARDED SEAL

NORTH SLOPE AND WINTERING AREAS

Bearded seals are present throughout the year in the Beaufort Sea. They are considered common, but not abundant, during late spring through early autumn, and less common during the months of heavy ice cover. In general, this species prefers to overwinter in areas of unstable or broken sea ice, where break-up occurs early. In Alaska, bearded seals overwinter infrequently in the fast-ice zone (Cleator and Stirling 1990). No reliable estimate of the abundance of bearded seals in the Beaufort Sea is currently available (Angliss and Lodge 2002). Their densities in the Western Beaufort Sea are highest during the summer and lowest during the winter (MMS 2002). The population in Alaska waters is largely migratory, with its center of abundance in the Bering Sea. Their most important habitat during winter and spring is active ice or offshore leads. Farther north, they are restricted to areas in the pack ice where conditions create persistent openings such as leads, polynyas (areas of open water in the pack ice), and flaw zones. These conditions become progressively more limited north of the Bering Strait and especially in the Beaufort Sea (Burns 1967; Burns and Frost 1979; Kelly 1988).

Bearded seals are the largest of the phocid seals, with adults weighing up to 800 pounds. Pupping takes place on the ice from late March through May, primarily in the Bering and Chukchi seas. However, some pupping occurs in the Beaufort Sea (MMS 2002).

Bearded seals are an important subsistence resource for Alaska Natives. The Inupiat of the North Slope use bearded seal skins to cover the *umiat* (skin boats used for spring whaling). There are currently no reliable estimates of the subsistence harvest, but from 1966 through 1977 Alaska Native hunters harvested an average of 1,784 bearded seals per year (Burns 1981).

PLAN AREA

There are no reliable estimates of bearded seal abundance in the Plan Area. They could occur up the Colville River Delta during the open-water season when bearded seals are distributed from shore to the pack ice. In early autumn, juveniles occasionally occur in river mouths and lagoons where low-salinity water freezes prior to the more salty waters of other nearshore areas (Burns et al. 2001).

POLAR BEAR

Polar bears are present in the Beaufort Sea year-round. They make a seasonal shift away from land as the landfast ice melts every summer. The Beaufort Sea stock has increased in number at an estimated annual rate of 2 percent or more during the past three decades (Amstrup et al. 2001). The Beaufort stock now numbers more than 2,000 animals and appears to be stable, showing little growth since the early 1990s (Angliss and Lodge 2002). Polar bear density in the region from Point Barrow to Cape Bathurst was estimated to be 1 bear per 197 km^2 to 1 bear per 284 km^2 (McDonald et al. 1999).

NORTH SLOPE

During late autumn to spring, polar bears are distributed widely, occurring on pack ice, landfast ice, and land. They are most abundant in the active flaw zone, where ringed seals, their principal prey, are most available (Burns et al. 2001). During the open-water season, polar bears are usually associated with the pack ice, although they could be seen on land or swimming in open water at considerable distances from the ice. As the pack ice comes closer to the coast during autumn, polar bears commonly swim ashore and scavenge beachcast carcasses or the remains of bowhead whales taken by subsistence hunters (Kalxdorff and Proffitt 2003).

Unlike other bears, male and non-pregnant female polar bears are active all winter. Pregnant females make maternal dens in deep snowdrifts during late October to early November (Durner et al. 2003; Amstrup and Gardner 1994). Between spring 1982 and spring 2003, 186 maternal dens were discovered between 137°W and 167°W longitude. Of those, 52 percent were on land or landfast ice and 48 percent were on pack ice (USGS 2002). Female polar bears produce one or two cubs (usually two) that are born in dens in December to January. The mothers and their cubs emerge from maternal dens in late March to early April, and those that were on land typically go to sea (Amstrup 2000).

Historically, polar bears have been hunted for subsistence, as well as by sport hunters. Between 1960 and 1972, an average of 260 polar bears were harvested annually from the Beaufort Sea, including both subsistence and sport hunters (Amstrup et al. 1986; Schliebe et al. 1995). In 1972, sport hunting in Alaska stopped, and the subsistence harvest in the Beaufort Sea averaged 111 bears annually between 1980 and 1996 (Schliebe et al. 1995). Between 1995 and 2000, the average annual harvest from the Beaufort Sea stock was 32.2 bears (Angliss and Lodge 2002).

PLAN AREA

Historically, polar bears have denned in the Colville River Delta region in low numbers. The USFWS maintains records of historical den locations, which are shown on Figure 3.3.4.2-1.

BELUGA WHALE

NORTH SLOPE

Beluga whales from two stocks, the Beaufort Sea and the eastern Chukchi Sea, could be found in North Slope waters during the summer (Angliss and Lodge 2002). Starting in early spring, beluga whales of the Beaufort Sea stock migrate north from wintering areas in the Bering Sea and are usually seen at Point Barrow by mid-April. Belugas often travel near bowhead whales through the same leads and cracks. Once in the Beaufort Sea, most belugas travel through offshore leads to the eastern Beaufort Sea and Amundsen Gulf, where they spend part or all of the summer (Burns et al. 2001). Whales of the Beaufort Sea stock are found in the Mackenzie Delta intermittently throughout the summer and occur throughout the region until September (Richard et al. 2001). Satellite-tagging studies have shown that the males travel far northeast in late summer. Young are usually born from mid-June to mid-July and nurse for 12 to 18 months (Burns and Seaman 1985).

The Beaufort Sea stock of beluga whales is estimated to include more than 39,000 animals, based on data from an aerial survey conducted in 1992 (Angliss and Lodge 2002). During the summer, most members of the Beaufort Sea stock are found in the eastern Beaufort in Canadian waters, although a few are found in low density throughout the western Beaufort (Burns et al. 2001).

Return migration from Canadian waters during the late summer and autumn is primarily through offshore waters near and beyond the edge of the continental shelf. Belugas travel west both in and near the pack ice front and through open water south of the pack ice (Burns and Seaman 1985; Treacy 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2002a, 2002b). Westward migration begins in mid-summer and continues for an extended period into the autumn. Migration of satellite-tagged whales through Alaskan waters lasted from 8 to 19 days (Richard et al. 2001).

The eastern Chukchi stock summers primarily in the Kasegaluk Lagoon system near Point Lay, Alaska, but satellite tagging studies have confirmed that many of these whales move north into offshore waters of the Beaufort Sea during late July and early August (Suydam et al. 2001). This is about the same time the belugas of the Beaufort Sea stock begin migrating west (Frost et al. 1993; Burns and Seaman 1985). The eastern Chukchi belugas are found in offshore waters and are unlikely to be found in Harrison Bay or near the Plan Area.

Inupiat hunters take belugas from the Beaufort Sea stock in low numbers. The Alaska Beluga Whale Committee (ABWC) reports that between 1993 and 1997, Inupiat hunters took an annual average of 61 belugas (range 42 to 85) (Frost and Suydam 1995; Frost 1998). During the same time, Canadian Inupiat hunters harvested an average of 123 (106 to 140) whales from the Beaufort Sea stock (Norton et al. in press).

PLAN AREA

There are limited records of coastal sightings of beluga whales near the Colville River Delta. Helmericks (cited in Hazard 1988) reported that belugas were common near shorefast ice in the Colville River Delta region until ice moved offshore in July. Seaman et al. (1981) reported sightings of a few groups (ranging up to 100 belugas) during fall migration north and east of the Colville River Delta near Jones, Pingok, and Thetis islands. Recently, Nuiqsut hunters have reported that belugas have been seen in the Nigliq Channel in the Colville River and were seen stranded in shallow water in the Fish Creek Delta (Lampe 2003). In general, nearshore waters are ice covered during the spring migration, and belugas come nearest the Colville River Delta during the fall migration. However, during both spring and fall migrations, the numbers that could occur near the Delta are only a small proportion of the main migration that occurs farther offshore

3.3.5 Endangered and Threatened Species

Three species listed as endangered or threatened under the ESA occur in the Plan Area or in the waters of Harrison Bay offshore of the Plan Area. These species are the bowhead whale (*Balaena mysticetus*) and two bird species, the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*). Bowhead whales are uncommon in Harrison Bay but have been observed there. The spectacled eider is more common than Steller's eider in the Plan Area and has been recorded on aerial surveys in the Colville River Delta and throughout the area proposed for the ASDP (Burgess et al. 2003a, 2003b; Johnson et al. 2003b). Steller's eider is an uncommon or rare species in the Prudhoe Bay and the eastern National Petroleum Reserve-Alaska areas, although a few sightings have been recorded in the Plan Area (Johnson and Stickney 2001; Johnson et al. 2003b).

This section describes the occurrence of the three ESA-listed species in the Plan Area, as well as general information for the entire North Slope. Additional information is available in recent EISs, environmental assessments, and planning documents, including the Liberty Development and Production Plan (MMS 2002b), the Beaufort Sea Oil and Gas Development/Northstar Project (USACE 1999), the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a), and the Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a).

3.3.5.1 Bowhead Whale

The bowhead whale is classified as endangered under the ESA and as depleted under the MMPA. The bowhead whale was listed as endangered in 1970, but no critical habitat has been designated for this species. Recently Shelden et al. (2001) suggested that the Bering/Chukchi/Beaufort Sea (BCBS) stock of bowheads should be delisted under the ESA.

NORTH SLOPE

The BCBS stock of bowhead whales is the largest of the five stocks that occur in the Arctic and subarctic. The size of the stock was estimated at 10,400 to 23,000 animals in 1848, before commercial whaling decreased the stock to between 1,000 and 3,000 animals by 1914 (Woodby and Botkin 1993). This stock has slowly increased since 1921 when commercial whaling ended, and now numbers approximately 10,020 whales (George et al. 2003). The population has increased at an annual rate of 3.3 percent from 1978 to 2001 (George et al. 2002).

Bowhead whales occur in seasonally ice-covered seas, generally remaining close to the packice edge. Most of the BCBS bowheads winter in open water areas amid sea ice and along the edges of the pack ice in the western and central Bering Sea (Braham et al. 1984). BCBS bowheads are distributed in summer in a broad area from Amundsen Gulf and the Eastern Beaufort Sea to the eastern part of the East Siberian Sea.

MIGRATION

The spring migration typically begins in late March to early April, depending on ice conditions. During the spring migration, bowheads follow predictable leads that form along the coast of western Alaska to Point Barrow. From Point Barrow eastward to Amundsen Gulf, the leads and the migration occur farther from shore. From April to June most bowheads are distributed along a migration corridor that extends from their Bering Sea wintering grounds to their feeding grounds in the eastern Beaufort Sea (Moore and Reeves 1993). An unknown and probably variable number of bowhead whales could migrate westward to feeding grounds in the western Chukchi Sea (Bogoslovskaya et al. 1982).

BCBS bowheads migrate in pulses, which are groups migrating at different times (Ljungblad et al. 1986). Inupiat traditional knowledge (summarized in Braham et al. 1980) holds that the pulses are segregated by age and sex. The first two pulses are generally adults without calves or subadults, while cows with calves and large males do not arrive until the third and final pulse. The first migrants are usually seen near Point Barrow in mid-April but may arrive later in heavy ice years (Krogman et al. 1989). After passing Point Barrow, most of the bowheads travel east through offshore leads in the continuous pack ice to feeding grounds in the eastern Beaufort Sea (Richardson and Thomson 2002).

Bowheads that have summered in the eastern Beaufort Sea begin the fall migration in late August to September and are usually out of the Beaufort Sea by late October (Treacy 1988-1997, 2000, 2002a, 2002b; Moore and Reeves 1993). The fall migration route extends from the eastern Beaufort Sea, along the continental shelf across the Chukchi Sea, and down the coast of the Chukchi Peninsula (Moore and Reeves 1993). Bowheads often feed opportunistically during the westward migration, sometimes close to shore (Richardson and Thomson 2002; Treacy 2002b).

The bowhead migration route across the Chukchi Sea to the Chukchi Peninsula is less well defined than across the Beaufort Sea. Most whales swim southwest to the coast of Chukotka (Moore and Clarke 1990), but a few sightings north of 72°N suggest that some whales take a more northerly route, perhaps toward Herald and Wrangel islands (Braham et al. 1984).

FORAGING

Examination of stomach contents from whales taken in the Inupiat subsistence harvest indicates that bowhead whales feed on a variety of invertebrates and small fishes (Lowry 1993). A minimum of 62 species of animals were identified, with crustacean zooplankton, primarily copepods and euphausiids, being the most important foods of bowheads in Alaskan waters (Lowry 1993). Generally, bowheads feed preferentially in areas with a higher than average zooplankton concentration (Griffiths et al. 2002b). Bowheads feed throughout the water column in the Beaufort Sea (Würsig et al. 1985).

Feeding in BCBS bowheads appears to be concentrated in the Eastern Beaufort Sea (mostly in the Canadian Beaufort Sea) in the summer and in the Bering Sea in the winter (Würsig et al. 1985; Schell et al. 1987; Schell and Saupe 1993). They appear to feed only occasionally during the spring (Carroll et al. 1987) and fall (Richardson 1987; Richardson and Thomson, 2002) migrations, and it is unclear how important feeding during the migration is. Richardson and Thomson (2002) estimated that bowheads derive, on average, 2.4 percent of their annual energy requirements from the Eastern Alaska Beaufort Sea, where they spend relatively little time. However, the total contribution from this area is highly variable (from <2 percent to 16 percent) , depending on the year and the individual whale. Several other aspects of bowhead whale foraging are described by Richardson and Thomson (2002).

REPRODUCTION

BCBS bowheads mate and calve during the spring migration from the Bering Sea to the Beaufort Sea (Nerini et al. 1984), although sexual activity has been observed as early as January and as late as October (Koski et al. 1993; Würsig et al. 1993). Female bowheads probably become sexually mature when they are approximately 13.5 to 14.0 meters long and males when they are 12 to 13 meters long (Koski et al. 1993). The calving interval for bowhead whales appears to be at least 3 years, but could be longer (Koski et al. 1993).

SURVIVAL AND MORTALITY

Commercial and subsistence whaling have been the greatest causes of bowhead mortality for the last several centuries. Currently, Alaskan Inupiat are allowed 67 strikes per year, which, if all were fatal, would result in 0.6 percent mortality of the stock from subsistence activity. The International Whaling Commission considers any strike to be fatal and counts the strike against the quota issued to Inupiat whalers. The Inupiat preferentially hunt immature whales (Philo et al. 1993c). Natural annual mortality in bowheads has been estimated at 3 to 7 percent (Breiwick et al. 1984; Chapman 1984), although it is difficult to estimate natural mortality since few bowheads that die of natural causes are seen.

PLAN AREA

Bowheads are not found in the immediate Plan Area. The residents of Nuiqsut hunt bowheads from camps on Cross Island east of the Plan Area during the fall migration (see Section 3.4.3).

During the spring migration eastward through the Beaufort Sea, the nearshore waters of Harrison Bay are completely ice-covered and bowheads are far offshore of the Colville River Delta following open leads in the sea ice. In years with heavy ice in the fall, bowheads are generally > 60 km offshore and in the years with light or moderate ice conditions bowheads generally occur >30 km from shore (CPAI 2002a, BLM and MMS 2003a).

During the fall migration, bowheads may occur closer to shore than during the spring migration, depending on ice conditions. During annual aerial surveys from 1987 to 2000 in the Beaufort Sea, a few bowheads were sighted in Harrison Bay, shoreward of a line between Oliktok Point and Cape Halkett (Treacy 1988, 1997, 2000, 2002a, 2002b). Other surveys have also shown that bowhead whales are rare nearshore in Harrison Bay and along the barrier islands east of the Colville River Delta (CPAI 2002a, Seaman et al. 1981, Moore and Reeves 1993). In years with light ice in the fall, surveys showed that bowheads occur in waters deeper than 10 meters (33 feet) (BLM and MMS 2003a, Miller, Elliot, and Richardson 1996). Other reports show bowheads are generally restricted to waters 60 feet (18 m) depth (CPAI 2002a, Seaman et al. 1981). The area offshore of the Plan Area is shallow, with the 30 foot depth contour more than three miles offshore of the Colville Delta. The aerial survey data and preference for deeper water indicate that bowhead whales are unlikely to occur in the shallow nearshore areas north of the Plan Area.

3.3.5.2 Spectacled Eider

The spectacled eider was listed as a threatened species in May 1993 (58 FR 27474) under the ESA throughout their range in the United States and Russia. Areas in Alaska designated by the USFWS as critical habitat include molting areas at Norton Sound and at Ledyard Bay in the southeast Chukchi Sea, the wintering area south of St. Lawrence Island, and the Yukon-Kuskokwim Delta breeding area (66 FR 9146-9185). There are no critical habitats on the North Slope designated by the USFWS for this species.

NORTH SLOPE

POPULATION STATUS AND RANGE

The spectacled eider was listed as a threatened species because of significant declines in the North American breeding population, particularly on the Yukon-Kuskokwim (Y-K) Delta. From the early 1970s to the early 1990s, numbers of pairs on the Y-K Delta declined by 96 percent from 48,000 to 2,000, apparently stabilizing at that low level (Stehn et al. 1993;Ely et al. 1994). On the North Slope, the minimum population estimate of breeding spectacled eiders based on aerial surveys between 1993 and 2002 ranged from a high of almost 9,300 birds in 1993 to a low of 5,800 birds in 1996 and back up to 6,662 birds in 2002 (Larned et al. 2001a; Larnedet al. 2003). A minimum (uncorrected for detection bias) long-term average (1992 to 2002) of 6,896 spectacled eiders occupied the surveyed portion of the Arctic Coastal Plain of Alaska (Larned et al. 2003), approximately 2 percent of the estimated 375,000 world population (Larned and Tiplady 1999). High-density nesting areas for spectacled eiders on the Arctic Coastal Plain are generally west of Dease Inlet (Figure 3.3.5.2-1). Nesting concentrations of spectacled eiders in the Plan Area are located in the Colville River Delta and south of Harrison Bay (Figure 3.3.5.2-1).

Most of the world spectacled eider population breeds in arctic Russia. Nonbreeders are not included in the Alaska estimate. They are assumed to remain at sea throughout the year until they attempt to breed at the ages of 2 to 3 years. The size of this population segment is unknown, as is their location during this period. Available life-history information for this species indicates they are long lived with relatively high adult survival and delayed sexual maturity. The North Slope population has shown a nonsignificant decreasing trend of approximately -1.26 percent (slope) from 1993 to 2002 with a corresponding mean growth rate of 0.99 (Larned et al. 2003). Additional details on population status and annual cycle may be found in Petersen et al. (2000).

During the nonbreeding season, from October/December to April, the only known spectacled eider wintering area is among leads in the pack ice southwest of St. Lawrence Island in the Bering Sea (Petersen et al. 1999). Eiders forage there principally by diving to obtain benthic invertebrates at varying depths less than 80 meters. In the marine environment, they feed primarily on clams, but also feed on snails, a variety of crustaceans, and members of various other taxa (Petersen et al. 2000). In recent studies in the northern Bering Sea wintering area, esophagi of sampled eiders contained only clams, mostly *Nuculana radiata*, with no trace of the once-dominant *Macoma calcarea* (Lovvorn et al. 2003). Changes in density of the latter species in the Bering Sea were coincident with an oceanic regime shift to warmer conditions.

Climate change at northern latitudes and associated changes in marine invertebrate communities and ice dynamics in spring may have had important impacts on the spectacled eider population, whose declines of 90 percent or more in western Alaska is essentially unexplained. Reasons for this decline are unknown but may be related to parasites and disease, subsistence harvest, predation, and potential alterations of Bering Sea food resources related to climatic regime shifts. Numerous studies have been conducted to investigate the potentail effects of spent lead shot on the Y-K Delta spectacled eider population (Franson et al. 1995; Flint and Grand 1997; Flint et al. 1997; Flint 1998; Grand et al. 1998).

Because few eiders are observed in marine areas along the Beaufort Sea Coast in spring, a majority could migrate to the nesting areas overland from the Chukchi Sea (TERA 2002). Although their location during the 1 to 2 month period between departure from the wintering area (April) and arrival in the breeding areas (early June) is unknown, it likely contains leads and polynyas nearest to the breeding areas (Lovvorn et al. 2003).

Routes traveled by spectacled eiders during spring migration are not well known. Generally, they have been recorded passing Point Barrow and/or arriving at the breeding areas in late May to early June (Johnson and Herter 1989). Although leads are important for many species migrating in this region, few spectacled eiders have been recorded using the lead system 5 to 6 km offshore extending eastward from Point Barrow (Woodby and Divoky 1982; Suydam et al. 2000). Suydam et al. (1997) recorded 55 spectacled eiders among 213,477 king and common eiders passing Point Barrow in spring 1994. Low numbers (0.5 to 0.7 birds per hour) have been recorded at several points in Simpson Lagoon (Johnson and Richardson 1981), but some of these probably were movements of local birds rather than migrants. Thus, because relatively few spectacled eiders are seen in marine areas, spring migration could be primarily overland from the Chukchi Sea (TERA 2002). Local observations that spectacled eiders flew inland north of Wainwright, reported by Myres (1958), support this view. They arrive on the breeding areas paired, often traveling in small flocks in late May and early June. Spectacled eiders have been observed to fly generally at altitudes less than 50 meters when over (marine) water (Petersen et al. 2000).

HABITAT

Spectacled eiders use a variety of habitats on the North Slope including the Plan Area. The USFWS identified five primary constituent elements considered to be important to this threatened species that could require special management considerations or protection: (1) all deep water bodies; (2) all water bodies that are part of basin wetland complexes; (3) all permanently flooded wetlands containing either *Carex aquatilis*, *Arctophila fulva*, or both; (4) all habitat immediately adjacent to these habitat types; and (5) all marine waters out to 25 miles from shore, the associated aquatic flora and fauna in the water column, and the underlying benthic community (65 FR 6114). However, large-scale landscape features that provide protection from predators such as the arctic fox could be more important indicators of nesting habitat than small-scale habitat features (Pearce et al. 1998).

NESTING, BROOD-REARING, STAGING, AND FALL MIGRATION

Currently the known primary nesting grounds are the Y-K Delta, the Arctic Coastal Plain (Kasegaluk Lagoon to the Sagavanirktok River) of Alaska, and in the Chaun Gulf and the Kolyma, Indigirka, and Yana river deltas of arctic Russia. With the exception of a few scattered areas in the Northwest National Petroleum Reserve-Alaska, spectacled eiders occur at low density on the Arctic Coastal Plain (Larned et al. 2001a, b; Ritchie and King 2002). The highest densities determined from FWS aerial surveys in 1998 to 2001 were found within 70 km of the coast between Barrow and Wainwright, with smaller areas northeast of Teshekpuk Lake (Figure 3.3.5.2-1). Overall density was determined to be 0.24 birds per km^2 in the Eider Survey area, based on observations of 304 birds in 2001 (Larned et al. 2001a, b), and 0.22 in 2002 (Larned et al. 2003). Before nesting, eiders occupy a variety of wetland and aquatic habitats (Anderson et al. 1996). Available information suggests female spectacled eiders return to the vicinity of previous nests. Spectacled eiders are dispersed nesters (Derksen et al.1981; Warnock and Troy 1992), occurring at a low density of 0.03 to 0.79 birds per km^2 (Larned and Balogh 1997) within approximately 70 km of the coast. Higher density nesting and broodrearing areas occur south of Peard Bay, including the Kugrua and Kungok river drainages, south of Barrow; and adjacent to Dease Inlet, including the Meade, Chip, and Inaru river drainages. Tundra-nesting habitat most often includes extensive wetlands (large shallow lakes, lake-basin wetland complexes) with emergent sedges and grasses and vegetated islands (Larned and Balogh 1997; Anderson et al. 1996). On the Colville River Delta, nearly half of the nests located were in salt-killed tundra and aquatic sedge with deep polygons (ABR, Inc. 2002). On the Arctic Coastal Plain, nesting begins in mid-June. Incubation lasts 20 to 25 days (Dau 1974; Kondratev and Zadorina 1992; Harwood and Moran 1993; Moran and Harwood 1994; Moran 1995), and eggs hatch from mid- to late July (Warnock and Troy 1992). Broodrearing in the central Arctic Coastal Plain occurs primarily in waterbodies with margins of emergent grasses and sedges, basin wetlands, and deeper lakes (ARCO Alaska, Inc. et al. 1997). Fledging occurs approximately 50 days posthatch.

On the nesting grounds, spectacled eiders occupy terrestrial wetlands and feed primarily by dabbling in shallow freshwater or brackish ponds, or on flooded tundra (Dau 1974; Kistchinski and Flint 1974). Food items include mollusks; insect larvae such as craneflies, trichopterans, and chironomids; small, freshwater crustaceans; and plants or seeds (Cottam 1939; Dau 1974; Kistchinski and Flint 1974; Kondratev and Zadorina 1992; Petersen et al. 2000).

Most male spectacled eiders depart the nesting areas from early June to early July (median date June 22 ±11 days) typically soon after females begin incubating. The number of pairs peaks in mid-June, and the number of males declines 4 to 5 days later (Anderson and Cooper 1994; Anderson et al. 1995; Smith et al. 1994). Males migrate a median distance of 6.6 km (average 10.1 km) offshore, spending up to a week in marine waters (Petersen et al. 1999a). Locations of satellite-transmitter-equipped males (Petersen et al. 1995) in the Beaufort Sea have been primarily in the western Harrison Bay and western Simpson Lagoon areas. A molt-migration is undertaken to Ledyard Bay molting area along the Chukchi Sea Coast southwest of Point Lay (Larned et al. 1995), and flocks of molting and staging eiders have been observed in Peard Bay, Norton Sound, south of St. Lawrence Island, and the Russian Far East prior to moving to the Bering Sea wintering area from October to December. Initial locations for many of the birds that were captured initially in the Prudhoe Bay area have been in the Chukchi Sea, suggesting they migrated overland or occupied the Beaufort Sea only briefly (TERA 2002). Although most males might make relatively little use of the Beaufort Sea prior to their molt-migration, at least in part due to the existence of little open-water habitat this early in the summer (TERA 2002), for some individuals the Beaufort Sea could be an important staging and migration route for as much as a week or two (Petersen et al. 1999a).

After nesting, most spectacled eider females with broods occupy coastal plain lakes with emergent grasses and sedges, or deep, open-water lakes. Departure from broodrearing sites for marine areas takes place on average August 29 (±10.5 days). However, departure of females takes place over an extended period from the third week of June through September, because females that fail to breed leave the nesting area early, those that lose their nests leave somewhat later, and those that lose broods leave still later (TERA 2002). When females depart the Arctic Coastal Plain, much more of the nearshore zone is ice free than when males depart; this open water in marine habitat allows extensive use of the western Beaufort Sea. Locations of females equipped with satellite transmitters in the Prudhoe Bay area indicate they stage and migrate in the Beaufort Sea and, like some males, use Smith and Harrison bays. Aerial surveys in late August 1999 recorded four spectacled eiders, a female with two young and an individual of unspecified sex in western Harrison Bay (Stehn and Platte 2000). In 2000, 13 female spectacled eiders tracked via satellite telemetry primarily used the western Beaufort (71 percent of all bird-days); however, areas near Stockton Island also were used extensively (17 percent of all bird-days) (Troy 2003). Half the tagged Prudhoe females were relocated twice in the Beaufort Sea, indicating a residence time of at least 4 days. Most previously were thought to spend relatively little time in the Beaufort (TERA 2002); however, these recent satellite-transmitter locations suggest they could remain in the Beaufort Sea for approximately 2 weeks (range 6 to 30 days) (Troy 2003). Although satellite-tagged females have been relocated more than 40 km offshore in the Beaufort Sea (TERA 2002), the median distance for migrating individuals is 16.5 km offshore (average 21.8 km) (Petersen et al. 1999a).

Numbers of spectacled eiders staging in the Beaufort Sea before southward migration generally are unknown. It is likely that relatively few birds occupy this area at any given time. This is suggested by relatively low numbers of birds counted on offshore aerial surveys (estimated densities of 0.01 to 0.16 birds per km^2) (Fischer 2001; Stehn and Platte 2000), as well as by the relatively low proportion of initial and repeat locations in the Beaufort Sea (once movement of an individual began) of transmitter-equipped birds that were captured initially in the central Beaufort Sea area. Aerial surveys in the central Beaufort Sea in July 2000 located 143 eiders in the deeper waters of Harrison Bay, including one flock of 100 birds (Fischer et al. 2002). A less intensive USFWS survey (flight lines twice as far apart), covering the entire Beaufort coastline from Point Barrow to Demarcation Point in July 2001, located 15 spectacled eiders off western Simpson Lagoon, in outer Smith Bay, and off the Plover Islands east of Point Barrow (Fig. 3.3.5.2-1) (Fischer 2001). These studies suggest that relatively low numbers of spectacled eiders would be expected to be found in either Beaufort or Chukchi seas during the staging/migration period from late June to September. However, these observations could underestimate numbers, because the limited aerial surveys could not accurately assess use of the entire area, and a substantial proportion of the “unidentified” eiders could have been spectacled. Observations made offshore in the Beaufort Sea by Divoky (1984) suggested that larger flocks might contain hundreds of individuals of this species. Divoky found the largest sitting flocks to contain more than 100 birds and flying flocks more than 300 individuals. During a late June to early July aerial survey in the Chukchi Sea between Peard Bay and Smith Bay, Dau and Anderson (2001) observed 40 spectacled eiders in nearshore waters. In 2002, they observed 10 in this area (Dau and Anderson 2001), and Dau and Hodges (2003) observed 1 in 2003.

PLAN AREA

POPULATION STATUS AND RANGE

A minimum estimated population of 7,149 spectacled eiders were on the Arctic Coastal Plain during 2003 (Larned et al. 2003b). An estimated 92 spectacled eiders used the Plan Area during 2003 (Colville River Delta extrapolated based on reported densities of 0.07 and 0.04 birds/km^2 [Johnson et al. 2004] and the National Petroleum Reserve-Alaska extrapolated based on a reported density of 0.02 birds/km^2 [Johnson et al. 2004]). Similar to the trend on the Arctic Coastal Plain, the numbers of nesting spectacled eiders in the Kuparuk oilfield area, just east of the Colville River Delta and the National Petroleum Reserve-Alaska, has remained relatively constant from 1993 to 2003 (Anderson et al. 2003). In contrast, numbers of spectacled eiders in the northeastern portion of the Colville River Delta declined by about 90 percent from 1987 to the mid-1990s (Helmericks 2004).

Spectacled eiders are found throughout the Colville River Delta from late May to early June (Figure 3.3.5.2-2), but most nesting and brood-rearing has been concentrated in the northwest portion of the outer Delta in recent years (Figure 3.3.5.2-3). Studies in Colville River Delta between 1996 and 2003 indicate that spectacled eiders nest primarily on the outer Delta (Figure 3.3.5.2-2) (PAI 2002a; Johnson et al. 2003a, 2004; Burgess et al. 2003a). Spectacled eiders nested historically in the Anachlik Colony and on Dune Island just east of the mouth of the Miluveach River (Helmericks 2004). Spectacled eider surveys during mid June 1993 to 2003 in the National Petroleum Reserve-Alaska portion of the Plan Area indicated that fewer eiders used this area than use the Colville River Delta (Figure 3.3.5.2-4). Spectacled eider nests have been located during ground-based searches at CD-5 (Figure 3.3.5.2-5). Eiders are harvested in the Colville River Delta (28 percent of eider harvest) during spring subsistence hunting primarily using boats to access the Delta and Harrison Bay (Figure 3.4.3.2-18).

NESTING, BROOD-REARING, AND STAGING

Pre-nesting eiders preferred Brackish Water, Salt Marsh, Salt-Killed Tundra, Deep Open Water with Islands, Shallow Open Water with Islands, and Aquatic Sedge Marsh with Deep Polygons in the Colville River Delta (Johnson et al. 2004). Nesting habitats used in the Colville River Delta (greater than or equal to 10 percent of observations) were Aquatic Sedge with Deep Polygons, Unpatterned and Patterned Wet Meadows (Johnson et al. 2004). Nesting habitats historically used in the Anachlik Colony area were Aquatic Sedge with Deep Polygons, Non-patterned Wet Meadow, and Patterned Wet Meadow (Helmericks 2004). Pre-nesting eiders preferred Salt Marsh, Shallow Open Water with Islands and Old Basin Wetland Complex and avoided Moist Tussock Tundra habitats within the portion of the proposed development in the National Petroleum Reserve-Alaska (Johnson et al. 2004). Nesting habitats used in the National Petroleum Reserve-Alaska were Deep Open Water with Islands, Shallow Open Water with Islands, Old Basin Wetland Complex, and Patterned Wet Meadow (Johnson et al. 2004).

Male spectacled eiders begin molt migrations during late June, with few birds (29 percent) using the nearshore Baufort Sea during molt-migration (Troy 2003). Male spectacled eiders spent a median of 10 days using the area of river discharge offshore of the Colville River Delta (Troy 2003). Female spectacled eiders move from tundra to marine waters in mid to late July, with all females using the Beaufort Sea for an average of almost two weeks, although few remained in the Colville River Delta area for more than a few days (Troy 2003). Few flocks of spectacled eiders were reported during summer offshore surveys between Cape Halkett and Brownlow Point; however, densities were highest in the deep and shallow water Harrison Bay areas in July 2000 and August 2000 (Figure 3.3.5.2-1) (Fischer et al. 2002). Flock sizes ranged from 1 to 100 birds, with the largest flocks in the deep areas of Harrison Bay (Fischer et al. 2002).

The proposed CD-3 area is in the outer Colville River Delta that is used most heavily by spectacled eiders (Johnson et al. 2003b). This area supports some of the highest densities of pre-nesting, nesting, and brood-rearing spectacled eiders in the Colville River Delta (Figure 3.3.5.2-2 and 3.3.5.2-3) (Johnson et al. 2003b, 2004). During pre-nesting, densities of spectacled eiders in the CD-3 area in 2002 (0.20 indicated birds/km^2) (Johnson et al. 2003b) were comparable to densities recorded across the Arctic Coastal Plain (0.23 indicated birds/km^2) (Larned et al. 2003). Spectacled eiders were reported in 14 of 21 habitats available during the pre-nesting period. 7 to 14 spectacled eider nests were found during nest searches in the proposed CD-3 area during 2000 to 2002, with a mean density of 0.6

nests/km^2 (Johnson et al. 2003b). A total of 10 nests had been found during ground searches of this area conducted in four previous years (Johnson et al. 2003b). Nests were found in most of the habitat types used during pre-nesting, with 39 percent of all nests in Salt-Killed Tundra, 21 percent in Aquatic Sedge with Deep Polygons, 18 percent in Patterned Wet Meadow, and 11 percent in Nonpatterned Wet Meadow. Surveys for spectacled eider broods have been conducted with less intensity than other surveys, but eiders use the same areas of the Colville River Delta during brood-rearing as during pre-nesting and nesting.

Studies in the CD-4 area in the inner Colville River Delta, as well as CD-5, CD-6, and CD-7 in the National Petroleum Reserve-Alaska, indicate much lower use of these areas by spectacled eiders during pre-nesting, nesting, and brood-rearing periods (Table 3.3.5-1) (Burgess et al. 2003a, 2003b, Johnson et al. 2004). The density of pre-nesting spectacled eiders in the CD-4 area averaged less than 0.01 indicated birds/km^2. The density of pre-nesting spectacled eiders in the National Petroleum Reserve-Alaska study area (0.02 to 0.04 indicated birds/km^2) was 25 to 50 percent of the density in the Kuparuk Oilfield and 10 to 20 percent of the density in the CD-3 area (Burgess et al. 2003b). One nest has been found each year in the CD-4 area for 2 of 3 years of nest searching (Burgess et al. 2003a). Seven nests were found at the National Petroleum Reserve-Alaska sites, four nests at CD-5 in 2002 and 2003, and three nests in a wetland basin in the northwest corner of the National Petroleum Reserve-Alaska study area during 2001 (Figure 3.3.5.2-5) (Burgess et al. 2003b; Johnson et al. 2004). One spectacled eider brood was observed in the National Petroleum Reserve-Alaska area northeast of CD-7 (Figure 3.3.5.2-5) (Burgess et al. 2003b; Johnson et al. 2004).

TABLE 3.3.5-1 GROUND-BASED SPECTACLED EIDER NEST DENSITIES (NEST/KM^2) IN THE PLAN AREA

		CD North	**CD South**	**Alpine West**	**Lookout**	**Spark**	
Spectacled Eider	**Alpine (6-year mean)**	**CD-3 (4-year mean)**	**CD-4 (3-year mean)**	**CD-5 (2-year mean)**	**CD-6 (2-year mean)**	**CD-7 (2-year mean)**	**National Petroleum Reserve-Alaska Area (2003)**
Nest Densities							
2000		1.1	0.2				
2001		0.4	0.1				
2002		0.4	0	0.2	0	0	
2003		0.7		0.2	0	0	0.1
Average	**0.04**	**0.65**	**0.09**	**0.21**	**0**	**0**	**0.1**

3.3.5.3 Steller's Eider

The Alaska breeding population of Steller's eider was listed as threatened on June 11, 1997 (62 FR 31748-31757). Historically, this species nested throughout much of western and northern coastal Alaska and in arctic Russia (Kertell 1991; Quakenbush and Cochrane 1993). However, the principal nesting areas now are in arctic Russia, with relatively few Steller's eider nests in Alaska on either the Arctic Coastal Plain or the Y-K Delta (Kertell 1991; Quakenbush and Cochrane 1993; Flint and Herzog 1999). Estimates of nesting Steller's eiders are complicated by the association of nesting with high lemming years (Quakenbush and Suydam 1999), but the numbers of Steller's eiders nesting in Alaska during suitable years is probably on the order of hundreds to 1,000 (Larned et al. 2003).

Areas in Alaska designated by the USFWS as critical habitat for the Alaska-breeding population of Steller's eiders include breeding habitat on the Y-K Delta and molting, wintering and spring staging habitats in marine waters including the Kuskokwim Shoals, Seal Islands, Nelson Lagoon and Izembek Lagoon (66 FR 8849-8884). There are no critical habitats on the North Slope designated by the USFWS for this species.

NORTH SLOPE

POPULATION STATUS AND RANGE

The Alaska-breeding population of Steller's eider was listed as threatened based on a substantial decrease in the species' nesting range in Alaska, a reduction in the number of Steller's eiders nesting in Alaska, and the resulting increased vulnerability of the remaining breeding population to extirpation. Historically, Steller's eiders nested in Alaska in two general regions: western Alaska where the species has been nearly extirpated, and the Arctic Coastal Plain where the species still occurs. In western Alaska, Steller's eiders occurred primarily in the coastal fringe of the Y-K Delta where the species was common at some sites in the 1920s, was still present in the 1960s, but was not recorded as breeding from 1976 to 1994 (Kertell 1991; Flint and Herzog 1999). In 1994 and 1996 to 1998, one to two nests were found at either or both the Tutakoke River and Hock Slough study sites on the Y-K Delta (Flint and Herzog 1999).

On the Arctic Coastal Plain, Steller's eiders historically occurred from Wainwright east, to nearly the United States-Canada border (Brooks 1915). The species might have abandoned the eastern Arctic Coastal Plain in recent decades, but it still occurs at low densities (0.01 per km^2) (Larned et al. 2001a; Larned et al. 2003) from Wainwright to at least as far east as Prudhoe Bay (Fig. 3.3.5.3-1). The majority of sightings in the last decade have occurred east of Point Lay, west of Nuiqsut, and within 90 km (56 miles) of the coast (Barrow Triangle). Near Barrow, Steller's eiders still occur regularly, although they do not nest annually. In some years, up to several dozen pairs could breed in a few square km. The species has been found at highest density (0 to 3.0 pairs per km^2) during road surveys in the core nesting area near Barrow (Quakenbush, et al. 1995). Intensive aerial surveys in the area between Admiralty Bay and the Chukchi Sea from 1999 to 2001 recorded densities of 0.02 to 0.08 birds per square kilometer (44-112 birds observed during 3 years) (Ritchie and King 2002). In 2002 and 2003, respectively, these investigators recorded an indicated total of 4 birds and 8 birds and a density of less than 0.01 birds per km^2 (Ritchie and King 2003).

Contemporary aerial breeding-pair surveys conducted in late June indicate a population averaging approximately 1,000 birds from 1986 to 2000 (Mallek 2001). A separate set of aerial surveys, timed in mid-June, indicates a smaller population, averaging approximately 200 birds from 1993 to 2001 (Larned et al. 2001a). These surveys likely underestimate actual population size because an unknown proportion of birds are missed when counting from aircraft, and no species-specific correction factor has been developed and applied. Nonetheless, these observations indicate that hundreds or low thousands of Steller's eiders occur on the Arctic Coastal Plain. These surveys do not demonstrate a significant population trend over the last decade. However, based on the observed interannual variability, it is estimated that it would take 14 years to detect a trend equivalent to a 50 percent change over 10 years (Larned et al. 2001b). Current sampling intensity is too low to provide useful trend data for this very rare species. There is some support for the hypothesis that Steller's eiders have abandoned formerly occupied areas and have reduced their breeding frequency in eastern portions of the Arctic Coastal Plain; if true, this likely indicates that the Alaska breeding population is in decline (Quakenbush et al. 2002).

Steller's eiders spend most of the year in marine habitats. During winter, most of the Steller's eiders concentrate along the Alaska Peninsula from the eastern Aleutian Islands to southern Cook Inlet in shallow, nearshore marine waters (Jones 1965; Petersen 1980). They also occur in the western Aleutian Islands and along the Pacific coast, occasionally to British Columbia, along the Asian coast (from the Commander Islands to the Kuril Islands), and some are found along the north Siberian coast west to the Baltic States and Scandinavia (Palmer 1976; Cramp et al. 1977). In spring, large numbers concentrate in Bristol Bay before migration; in 1992, an estimated 138,000 Steller's eiders congregated there before sea-ice conditions allowed movement northward (Larned et al. 1994).

NESTING HABITAT

In arctic Alaska, Steller's eiders nest and raise broods in areas dominated by low-centered polygons and shallow ponds with emergent grasses and sedges, wet sedge meadows, lakes, and lake basins (Fredrickson 2001). The presence of emergent plants seems to be important to brood-rearing Steller's eiders (Quakenbush and Cochrane 1993). In the Barrow area, water bodies with pendant grass (*Arctophila fulva*) had considerable use by Steller's eiders during pre-nesting, nesting, and brood-rearing periods (Quakenbush et al. 1995). Steller's eiders nest in association with snowy owls and pomarine jaegers (Quakenbush et al. 2002).

The USFWS identified the primary constituent elements of the proposed critical habitat as "small ponds and shallow water habitats (particularly those with emergent vegetation), moist tundra within 326 feet of permanent surface waters including lakes, ponds, and pools, the associated fauna, and adjacent nesting habitats" (65 FR 13267).

NESTING, BROOD-REARING, STAGING, AND FALL MIGRATION

Steller's eiders arrive paired on the Arctic Coastal Plain in early June. Nesting effort varies widely from year to year. In the 12 years from 1991to 2002, there were 6 "nesting years" (1991, 1993, 1995, 1996, 1999, 2000) when typical breeding activities occurred, and 6 "non-nesting years" (1992, 1994, 1998, 2001, 2002) when birds appeared in early summer, but no nests were found and Steller's eiders are believed not to have nested (Quakenbush et al. 1995; Rojek and Martin 2003). Four nests were found in 1997, but these were initiated late (early July) and none survived past mid-incubation (Rojek and Martin 2003). The reasons for the observed variation in nesting effort are unknown, but an association has been noted between nesting years and years of lemming abundance. Nest success could be enhanced in years of lemming abundance, because predators are less likely to prey on eider nests when small mammals are abundant. It also has been hypothesized that avian predators such as pomarine jaegers (*Stercorarius pomar*inus) and snowy owls (*Nyctea scandiaca*), which nest at high densities only when lemmings are abundant, could provide protection for nearby eider nests incidental to defense of their nesting territories (Quakenbush and Suydam 1999). If this hypothesis is correct, the presence of avian predators is an essential element of breeding habitat.

In nesting years, initiation dates are typically in the first half of June (Quakenbush et al. 1995), and hatching dates range from 7 July to 3 August (Quakenbush et al. 1998). Nests in Barrow are located in wet tundra, in areas of low-center polygons or low (indistinct flat-centered) polygons, frequently within drained lake basins (Quakenbush et al. 1998). Average clutch sizes at Barrow ranged from 5.3 to 6.3 in five different years, with clutches of up to eight reported (Quakenbush et al. 1995). Nest success (proportion of nests at which at least one egg hatched) at Barrow averaged approximately 18 percent from 1991 to 2003 (Rojek and Martin 2003). Egg loss was attributed mostly to predation by predators including jaegers, common ravens (*Corvus corax*), and possibly glaucous gulls (*Larus hyperboreus*) and arctic foxes (*Alopex lagopus*) (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). The fledging period is not known, but is estimated to be 37 days (Obritschkewitsch et al. 2001). Broods most often used ponds with emergent grass (*Arctophila fulva*) (Quakenbush et al. 1998). Broods were reared close to their nest site; eight broods tracked near Barrow in 1995 remained within 650 meters of their nest sites during the first 32 days after hatching (Quakenbush et al. 1998).

Males typically depart the breeding grounds after females begin incubating. Based on observations in the Barrow area, and on a small sample of birds equipped with satellite transmitters, males depart Barrow around the end of June or early July (Quakenbush et al. 1995; Obritschkewitsch et al. 2001). Both males and females tracked with satellite transmitters in a nonbreeding year dispersed across the area between Admiralty Inlet and Wainwright in late June and early July, with most birds entering marine waters by the first week of July. The satellite-tracked birds used coastal locations from Barrow to the Bering Straits and made extensive use of lagoons and bays on the north coast of Chukotka (P. Martin, USFWS 2004, pers. comm.). Females that fail in breeding attempts could remain near Barrow later in the summer; a single failed-breeding female equipped with a transmitter in 2000 remained near the breeding site until the end of July and stayed in the Beaufort Sea off Barrow until late August. Females and fledged young depart the breeding grounds in early to mid-September.

In mid-August, Alaska-breeding Steller's eiders migrate to molting areas, where they congregate in large flocks in protected waters. Concentrations of molting Steller's eiders have been noted in Russia on the Chukchi and Bering sea coasts, near St. Lawrence Island in the Bering Sea, and along the northern shore of the Alaska Peninsula (Kistchinski 1973; Fay 1961; Jones 1965; Petersen 1981). Satellite-tracked birds from Barrow molted at Nunivak Island, Cape Avinof (Kuskokwim Shoals), Nelson Lagoon/Port Moller, and Izembek Lagoon (USFWS, unpublished data).

PLAN AREA

Steller's eiders periodically are found on and near the Colville River Delta and the Plan Area (PAI 2002a). There have been a small number of sightings in the Plan Area in recent years (Noel et al. 2001; Noel et al. 2002c; Burgess et al. 2003b). Steller's eiders are rare in this area and extremely rare farther east (Figure 3.3.5.3-1) (Larned et al. 2003; Mallek et al. 2003).

3.4 SOCIAL SYSTEMS

This section describes the social, economic, cultural, infrastructure, and other elements of the North Slope environment related to human development. The assessment of the impacts on social systems in the North Slope is unique because of the presence of a single dominant resource extraction industry—the oil and gas industry—and a relatively small indigenous Native population that continues to practice subsistence living.

For this EIS, the discussion of social systems has been organized to include the following topics:

Topic	DEIS Section
Socioeconomic	**Socio-Cultural** – A description of the North Slope, overwhelmingly Native**,** communities and their culture (Section 3.4.1). **Regional Economy** – A description of regional economy and its relationship to the state economy (Section 3.4.2). **Subsistence Harvest and Uses –** A description of the local harvest of subsistence foods as a cultural and economic activity (Section 3.4.3). **Environmental Justice** – A determination if any of the local communities are environmental justice populations for which an assessment of disproportionate impacts must be made (Section 3.4.4).
Cultural Resources	**Cultural Resources** – A description of the pre-history and general presence of cultural resource sites within the Plan Area (Section 3.4.5).
Infrastructure	**Land Uses and Coastal Management** – A description of the land use management programs that govern use of lands within the Plan Area. Also includes a description of specific designations that pertain to lands within the Plan Area (Section 3.4.6) **Transportation** – A description of the systems that provide transportation to and within the Plan Area (Section 3.4.9)
Non-Subsistence Human Use	**Recreation** – A description of the types of recreation activities likely to occur in the Plan Area and the expected level of use (Section 3.4.7) **Visual** – A description of the landscape within the Plan Area from the perspective of visual resources management (Section 3.4.8)

3.4.1 Socio-Cultural Resources

The North Slope includes two relatively distinct populations: local residents who are predominately indigenous Inupiat Natives, and the oil and gas industry workers who rotate on a regular schedule and are temporary worker/residents in the region. As temporary residents, the oil and gas industry workers have limited participation in the local economy, and their needs for most services are provided by industry. On the other hand, full-time residents of the region form the primary social structure and the local economy. The assessment of impacts in this EIS focuses on the full-time residents of the North Slope. The degree to which the proposed expansion of the oil and gas industry could have direct and indirect effects on the culture of the Native population is assessed as impacts on the socio-cultural characteristics of affected North Slope communities.

3.4.1.1 Cultural History and Cultural Values

The north coast of Alaska has had human population for a long period of time. The earliest known site associated with earlier inhabitants of this region dates to approximately 6,000 years ago. Human prehistory is represented by isolated localities along the coast of the Beaufort Sea from Point Barrow to the Canadian border near Demarcation Point. Knowledge of human occupation has been recorded for approximately 150 years, and development of an understanding of the cultural history of the region began in the early twentieth century (Lobdell 2000). A more complete description of the cultural prehistory of the region can be found in Section 3.4.5, Cultural Resources.

At present there are four communities in or adjacent to the Plan Area. They include Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass. These communities are part of the NSB, a home rule municipal subdivision of the State of Alaska. The majority of the population is Inupiat Eskimo.

Traditionally, the cultural values of the Inupiat focused on their close relationship with natural resources, specifically game animals upon which they depended on for subsistence and survival. The Inupiat also had a close relationship to the supernatural, with specific beliefs in animal souls and beings controlling the movements of animals. Other values included a strong emphasis on the community, its needs, and the support of other individuals. Although there have been substantial social, economic, and technological changes in Inupiat lifestyle, subsistence continues to be the central organizing value of Inupiat socio-cultural systems. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Indeed, “most Inupiat still consider themselves primarily hunters and fishermen” (Nelson 1969) — a refrain North Slope residents voice repeatedly (Kruse et al. 1983; ACI, Courtnage, and Braund 1984; IAI 1990a, 1990b; MMS 1994). Task groups are still organized to hunt, gather, and process subsistence foods. Cooperation in hunting and fishing activities also remains an integral part of Inupiat life, and a major component of significant kin ties is the identity of those with whom one cooperates (Heinrich 1963). Large amounts of subsistence foods are shared within the community, and the people one gives to and receives from are major components of what makes up significant kin ties (Heinrich 1963; ACI, Courtnage, and Braund 1984).

On the North Slope, “subsistence” is much more than an economic system. The hunt, the sharing of the products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men, and good hunters are often respected leaders. Good health comes from a diet derived from the subsistence hunt. Young hunters still give their first game to the community elders, and generosity brings future success.

The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities occurring in Inupiat society. However, cultural value is also apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations (some families will dominate one type of government administration or one organization, for example, the Village Corporation), employment, sports activities, and membership in voluntary organizations (Mother’s Club, Search and Rescue, etc.) (ACI, Courtnage, and Braund 1984).

3.4.1.2 Social Organization

The social organization of Inupiat communities is strongly based on kinship. Kinship forms "the axis on which the whole social world turn[s]." (Burch 1975a, 1975b) Historically, households were composed of large extended families, and communities were kinship units. Today, there is a trend away from the extended-family household because of increased mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Inupiat society continue to be important and remain a central focus of social organization.

The social organization of North Slope Inupiat encompasses not only households and families, but also wider networks of kinsfolk and friends. These types of networks are related through overlapping memberships, and they are embedded in those groups responsible for hunting, distributing, and consuming subsistence resources (Burch 1970). An Inupiat household on the North Slope could include a single individual or group of individuals who are related by marriage or ancestry. The interdependencies among Inupiat households differ markedly from those found in the United States as a whole. In the larger non-Inupiat society, the demands of wage work emphasize a mobile and prompt workforce. While modern transportation and communication technologies allow for contact between parents, children, brothers, sisters, and other extended-family members, more often than not, independent nuclear households (father, mother, and children) or conjugal pairs (childless couples) form independent "production" units that do not depend on extended-family members for the day-to-day support of food, labor, or income. In contrast to the non-Native culture, in the Inupiat culture individual family groups depend on the extended family for support and provision of day-to-day needs.

Associated with these differences, the Inupiat hold unique norms and expectations about sharing. Households are not necessarily viewed as independent economic units, and giving—especially by successful hunters—is regarded as an end in itself, although community status and esteem accrue to the generous. The sharing and exchanging of subsistence resources strengthen kinship ties (Nelson 1969; Burch 1971; Worl 1979; ACI, Courtnage, and Braund 1984; Luton 1985; Chance 1990).

3.4.1.3 Economic Organization

The potentially affected communities within the region—Barrow, Nuiqsut, Atqasuk, and Anaktuvuk Pass—are inhabited predominantly by Inupiat residents. These residents have a historical and cultural tie to subsistence production and consumption as one of their main economic activities. There is a dual subsistence/cash composition to the overall economic structure of the communities. Barrow, with its role as the regional economic hub of the NSB, has the greatest opportunities for residents to find and engage in employment. Income and employment opportunities are much less prevalent in the more remote villages.

Subsistence production does not have a direct market value since harvested resources are not bought and sold in markets. However, it does have an economic value and is one of the main economic activities for residents of North Slope communities. Subsistence production has value both in consumption and in cultural activities of residents. Production of subsistence food can be viewed as an import substitute for food shipped into the community that is both very expensive and less culturally attractive to residents. To assess the level of economic activity represented by subsistence production an economic value could be assigned by assuming the local cost of substitute foods as an equivalent value. However, this method does not consider the cultural value and benefits inherent in the production and consumption of subsistence foods.

3.4.1.4 Institutional Organization and Community Services

Community services in all North Slope communities are primarily provided by the NSB. However, village municipal governments, regional and village tribal governments and regional and village ANCSA corporations also play a role in community services.

Among the services provided by the NSB to Nuiqsut, Barrow, Atqasuk, Anaktuvuk Pass, and other North Slope communities. These services include public safety, public utilities, fire protection, and some public health services. The NSB was incorporated on July 1, 1972, and adopted its Home Rule Charter on April 30, 1974. With approximately 94,000 square miles, the NSB is the largest borough in Alaska. It encompasses eight villages: Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright.

Revenues primarily from the taxation of oil industry facilities fund NSB services. These revenue sources are currently stable and the borough's permanent fund account continues to grow, as does its role as primary employer in the region. However, as North Slope oil production continues to decline, future fiscal and institutional growth of the NSB can also be expected to slow since the borough is highly dependent upon property taxes for oil-related facilities. This slowing would be caused by economic constraints on Inupiat participation in oil-industry employment, growing constraints on the statewide budget, and the Alaska legislature's threat to limit the NSB's bonding authority (Kruse et al. 1983; Harcharek 1992, 1995).

The ASRC, formed under ANCSA, runs several subsidiary corporations. Most of the communities also have a village corporation, a Traditional Village orIndian Reorganization Act (IRA) Council, and a city government. The IRA and village governments have not provided much in the way of services, but village corporations have made many service contributions. The ICAS, the regional tribal government, has recently taken on a more active and visible role in regional governance.

3.4.1.5 Community Health and Welfare

The EISs for MMS prepared for Lease Sales 97, 124, 144, 170; the Northstar and Liberty projects; and the National Petroleum Reserve-Alaska detail issues about changes in employment, increases in income, decreases in fluency in Inupiaq, rising crime rates, and substance abuse (MMS 1987a, 1990b, 1996a, 1998; MMS Alaska OCS Region 2002b; BLM and MMS 1998a; USACE 1996). These documents also discuss the fiscal and institutional growth of the NSB. These discussions are incorporated by reference and summarized below. In addition, Smythe and Worl (1985) and Impact Assessment, Inc. (IAI) (1990a) detail the growth and responsibilities of local governments.

Recent statistics on homicides, rapes, and wife and child abuse present a sobering picture of some aspects of life in NSB communities. Violent deaths account for more than one-third of all deaths on the North Slope. The Alaska Native Health Board notes the "overwhelming involvement of alcohol (and drug) abuse in domestic violence, suicide, child abuse, birth defects, accidents, sexual assaults, homicide and mental illness." (Alaska Native Health Board 1985) The lack of comparable data makes it impossible to compare levels of abuse and violence between aboriginal (before contact with Caucasians), traditional (from the time of commercial whaling through the fur trade), and modern (since World War II) Inupiat populations. Nonetheless, it is apparent from reading earlier accounts of Inupiat society that there has been a drastic increase in these social problems, although a study conducted in the early 1980s on the North Slope indicates that no direct relationship was found between energy development and "accelerated social disorganization." (Kruse et al. 1982, cited in IAI 1990b) Studies in Barrow (Worl and Smythe 1986) detail the important changes in Inupiat society occurring in the last decade as a response to these problems. Services from outside institutions and programs have recently begun to assume a greater responsibility for functions formerly provided by extended families. There is an array of social services available in Barrow that may be more extensive for a community of this size than anywhere in the United States. (Worl and Smythe 1986). The health and welfare of North Slope village residents has benefited from the construction of community facilities, modern water and sewer systems, and village clinics. Oil and gas development on the North Slope has provided funding for child emergency shelters, behavioral outpatient and residential programs providing mental health care and counseling from substance abuse and domestic violence, and assisted-living services for elders (NRC 2003). At the same time, oil and gas development has also contributed to negative health effects by contributing to stress and anxiety about subsistence. Disruption of traditional social systems and subsistence practices has coincided with increased incidence of cancer, diabetes, alcoholism, drug abuse, and child abuse. Residents also express concern that smog and haze near some villages may be causing an increase in asthma.

Recent health effects studies related to the Native population have shown that:

- One of the leading causes of mortality in the North Slope Native population continues to be cancer. Among the various forms, lung cancer rates are 50 percent higher than Alaska's general population and twice as high as the U.S. population. The 2000 update of the Alaska Native tumor registry showed that the rate for lung cancer in Alaska Natives exceeds the U.S. rate among both men and women by 48 percent (Lanier et al, 2001). Lung cancer is associated with smoking; survey data from 1994 to 1996 shows that the prevalence of smoking among the Alaska Native population is 40.6 percent for women and higher for men (Office of Women's Health 2001).
- Asthma prevalence has increased nationally 75 percent since 1980 and rates for children have risen 86.8 percent between 1982 and 1995. Local community members working in health care have cited increased asthma rates among the local population. The USEPA has found that children who breathe second-hand smoke are more likely to suffer from: bronchitis and pneumonia, wheezing and coughing spells, more ear infections, and more frequent and severe asthma attacks. According to the National Cancer Institute, there is a connection between second-hand smoke and Sudden Infant Death Syndrome (SIDS), new cases of childhood asthma, and behavioral and cognitive problems in children.
- Local site specific studies have not been performed to determine if there is a link between air quality (both outdoor and indoor) and health effects. Existing air quality on the North Slope and in Nuiqsut is well within national and state standards for all criteria pollutants, including particulate matter (PM_{10}), which is the pollutant most associated with asthma and other respiratory ailments. Local ambient air quality monitoring has recorded occasional short term episodes of increased particulate from wind-born dust but annual particulate concentration is less than 20 percent of the allowable standards. The 2003 NRC report recommended that studies be undertaken to distinguish between locally derived emissions and long-range transports of air contaminants from other regions.

The baseline of the present socio-cultural system includes change and strain. The very livelihood and culture of North Slope residents come under increasing scrutiny, regulation, and incremental alteration. Increased stresses on social well-being and on cultural integrity and cohesion come at a time of relative economic well-being. The expected stresses on the culture by the decline in Capital Improvements Program (CIP) funding from the state have not been as significant as once expected. The buffer effect has come mostly through the dramatic growth of the borough's own permanent fund, the NSB taking on more of the burden of its own capital improvement, and its emergence as the largest employer of local residents. However, borough revenues from oil development at Prudhoe Bay are declining, and funding challenges (and subsequent challenges to the culture) continue as the state legislature alters accepted formulas for borough bonding and funding for rural school districts.

3.4.1.6 Population and Employment

A summary of the socioeconomic characteristics of the communities in and adjacent to the Plan Area is shown in Table 3.4.1-1. The 2000 census counted 7,385 residents within the NSB. The largest component of the population, 68.4 percent, is Alaska Native/Native Americans. This is much higher than in the State of Alaska as a whole, with Alaska Natives/Native Americans comprising 15.6 percent of total residents statewide. In 2000, the average per capita income for the NSB was $20,540, which is approximately 10 percent less that the statewide average per capita income. The NSB resident median age was 27.0, which is 5 years younger that the statewide average age, and the average household size was 3.45, which is larger that the statewide average. The percentage of households in poverty status was 8.6 percent, approximately 2 points higher than the statewide average, and 17.3 percent of households earned less than $25,000 per year, which was less than the statewide average.

TABLE 3.4.1-1 SUMMARY OF SOCIOECONOMIC CHARACTERISTICS

	Population	Median Age	Native Residents	Average Household Size	Per Capita Income	Families in Poverty Status	Households Earning <$25,000/ year
State of Alaska	626,932	32.4	15.6 %	2.74	$22,660	6.7 %	20.9 %
NSB	7,385	27.0	68.4 %	3.45	$20,540	8.6 %	17.3 %
Barrow	4,581	28.8	57.2 %	3.27	$22,902	7.7 %	16.9 %
Nuiqsut	433	23.8	88.2 %	3.93	$14,876	3.2 %	14.2 %
Atqasuk	228	26.3	94.3 %	4.15	$14,732	25.0 %	19.6 %
Anaktuvuk Pass	302	25.7	87.6 %	3.36	$15,283	3.2 %	11.1 %

Source: U.S. Bureau of the Census, Census 2000

Figure 3.4.1.6-1, North Slope Employment By Sector for 2001, shows North Slope employment for 2001, which is the most recent year available, by nine employment sectors. This employment profile includes all wage employment within the NSB and includes both residents and nonresident workers. The largest employment sector for the NSB is mining, which consists almost entirely of oil and gas production. This sector accounts for 46.2 percent of total employment. The next largest sector is government, with 22.5 percent of total jobs. The service sector is the third largest, with 11.3 percent. Trade accounts for 6.3 percent of jobs, while the combined transportation/ communications/utilities sector accounts for 5.2 percent of total North Slope employment. Construction accounts for 6.4 percent, and the combined sector of financial/insurance/real estate accounts for 2 percent. Manufacturing is the smallest sector, accounting for 0.1 percent of total jobs. This employment profile is very different from the State of Alaska as a whole, where mining accounts for only 3.9 percent of total jobs (Bureau of the Census 2003) and the largest sectors are government at 27.1 percent and services at 25.2 percent.

The combined communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut had a workforce of 2,929, or 77 percent of the total NSB workforce. Nuiqsut, the one community within the Plan Area, had 176 workers, or approximately 5 percent of the regional workforceworkforce. The overall composition of the local workforce is shown in Table 3.4.1-2.

TABLE 3.4.1-2 LABOR WORKFORCE BY COMMUNITY – 1998

Employment Status	Total NSB Labor Force	Anaktuvuk Pass	Atqasuk	Barrow	Nuiqsut
Labor Force	3,823	147	98	2,508	176
Permanent/ Full-time	2,114	58	45	1,565	85
Temporary/ Seasonal	523	21	11	287	56
Part-time	222	12	8	91	13

Source: NSB, 1999.

According to State figures, unemployment in the NSB ranged from 3.5 to 9.4 percent during the period of 1975 to 2001 (www.labor.state.ak.us/research). The rate of unemployment for the NSB workforce in 1998 is shown in Table 3.4.1-3. Table 3.4.1-3 shows that within the NSB, unemployment ranges from a low of 7 percent at Anaktuvuk Pass to a high of 40 percent at Atqasuk. The unemployment rate for three of the four communities was less than the overall rate for the NSB, which was 16 percent. These rates of unemployment were considerably higher that the overall State of Alaska unemployment rate.

In addition to higher rates of unemployment, rates of less than full-time employment (employment less than 40 weeks per year) were also high. As shown in Table 3.4.1-3, the underemployment rate for the NSB was 27 percent. Within the four communities, this rate varied from 23 to 62 percent in 1998. Table 3.4.1-3 also shows the percentage of people who believe they were underemployed. In this case, of the four communities, only Nuiqsut had a rate higher than the NSB average. Twenty-seven percent of the workforce in Nuiqsut believe they were underemployed compared to 13 percent for the NSB as a whole.

TABLE 3.4.1-3 UNEMPLOYMENT AND UNDEREMPLOYMENT BY COMMUNITY – 1998

Employment Status	NSB Labor Force	Anaktuvuk Pass	Atqasuk	Barrow	Nuiqsut
Unemployment (%)	16	7	40	10	10
Underemployment (%)	13	7	6	12	27
(Those who believe they were unemployed)					
Underemployment (%)	27	23	44	24	62
(Those who worked less than 40 weeks in 1998)					

Source: NSB 1999

Some Alaska economists believe that Alaska's rural communities have a large percentage of "discouraged workers," or those who are involuntarily unemployed but are not counted in the state or federal unemployment data (Windisch-Cole 1996, pers. comm.). Other economists do not think the discouraged-worker hypothesis applies to the NSB, as it is believed that in a mixed cash-subsistence economy, people who do not have cash jobs for part of the year may not take one if offered to them (Berman 1997, pers. comm.).

A limited number of North Slope Alaska Natives have been employed in the oil-production facilities or associated work in and near Prudhoe Bay since production started in the late 1970s. In addition, Alaska Natives who reside on the North Slope are not inclined to relocate for employment (MMS 1993). This historical information is relevant to assessing potential economic effects of oil and gas exploration and development on the North Slope's Native population. A 1993 study contracted by the MMS found that the 34 North Slope Natives who were interviewed accounted for half of all North Slope Natives who worked at Prudhoe Bay in 1992. The study also found that the North Slope Natives employed at Prudhoe Bay made up less than 1 percent of the 6,000 North Slope oil-industry workers (MMS 1993). This pattern is confirmed by data from 1998 that found that 10 NSB Inupiat residents were employed in the oil industry that year**;** this employment pattern has continued (BLM and MMS 2003, Table III-13).

A primary goal of the NSB has been to create employment for Alaska Native residents. Many Natives have been hired for the NSB's construction projects and operations. In contrast, only a few who are NSB residents hold jobs at the Prudhoe Bay industrial enclaves, indicating a bias by Native residents toward NSB employment. Pay scales for jobs provided by the NSB have parity with those offered by industry, while the working conditions and flexibility offered by the borough are considered by Native employees to be superior to those in the oil and gas industry. This seems to be especially important to community members who participate in subsistence hunting and require flexible work schedules during the subsistence harvest.

The NSB has tried to facilitate employment of Alaska Natives in the oil industry at Prudhoe Bay. However, greater participation of Alaska Natives from local communities in the oil and gas industry workforce is expected to require job skills training and work schedule flexibility to allow participation in subsistence activities. The NSB is also concerned that the oil industry recruits with methods common to western industry. The NSB would like the industry to make serious efforts to increase hiring of borough residents (Nageak 1998). One industry participant, BPXA, has established the Itqanaiyagvik Program whose purpose is to increase British Petroleum's (BPs) hire of Natives who are NSB residents. This joint venture between the ASRC and its oilfield subsidiaries is coordinated with the borough and the NSB School District (BPXA 1998b). Another industry participant, ConocoPhillips, has partnered with ASRC and offered training programs for North Slope residents interested in oilfield maintenance and heavy equipment maintenance. Twenty North Slope residents spent their summer in 2002 working and training in these areas. ConocoPhillips has worked closely with Kuukpik Corporation, ASRC, and other companies to hire and train Alaska Natives. ConocoPhillips, in cooperation with Kuukpik Corporation, sponsors mentoring and training at the Alpine Field for North Slope residents (Mr. Wheathall, Nuiqsut Public Hearing 2003).

NUIQSUT

In April 1973, 27 families began the 150-mile move from Barrow to the Colville River (Brown 1979). These families re-established the village of Nuiqsut, named for earlier camps and settlements on the main channel of the Colville River. In the 1940s, most families that had been living in the lower Colville River and nearby coastal areas were forced to relocate to Barrow so that children could attend school. Upon their return, the families located the village of Nuiqsut on the Nigliq Channel of the Colville River to allow easy access to the river's main channel for fishing and hunting. The return to Nuiqsut in 1973 was motivated by a desire to revive traditional Inupiat values of hunting and fishing, and experience Inupiat social and cultural life.

The importance of Nuiqsut's cultural landscape to its people and the approaching oil and gas development in the Arctic triggered completion of a cultural plan in 1979. This plan was intended to be integrated at both planning and political levels to help the Nuiqsut people protect their traditional landuse area and perpetuate their subsistence way of life (Brown, 1979). The Nuiqsut cultural plan defined the cultural landscape by describing historic resources, hunting areas, and fishing sites (subsistence use areas) in the area. It also cited critical concerns of village residents and defined desired land use management roles of the NSB and the ASRC. Although subsistence use has changed since 1979, the village residents have many of the same concerns and priorities regarding preservation of historical, cultural, and subsistence resources.

Nuiqsut is undergoing rapid social and economic change with a new hotel, the influx of non-Inupiat oil workers from the nearby Alpine Field, the potential for further oil development, and a proposed state road to the community.

The population trend in Nuiqsut in recent years is shown on Figure 3.4.1.7-1. Between 1990 and 2000, the population of Nuiqsut grew at a rate of 2.2 percent per year, a rate that was slower than during the previous decade and slower than the growth of Barrow. However, Nuiqsut grew faster than both Anaktuvuk Pass and Atqasuk during this period.

Table 3.4.1-1 shows selected socioeconomic characteristics for Nuiqsut. In 2000, the average per capita income was $14,876, roughly two-thirds that of the State of Alaska as a whole and the NSB. The median age for Nuiqsut residents was 23.8, approximately 9 years younger than the state average and 3 years younger than the NSB as a whole. Average household size was 3.93, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 3.2 percent, and 14.2 percent of households earned less than $25,000 per year. The household poverty rate was less that the NSB average but more that the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Some initial results from an ongoing study, Local Control and Impacts of Oil and Gas Development: Nuiqsut Case Study (Haley 2004), indicates that residents of Nuiqsut have a trend of increased per capita and household incomes, beginning in 1998 as a result of Alpine Field-related activities. This increasing trend is not shared by other North Slope communities according to the preliminary results of the study. More detailed information may come available when the full study is published.

As shown in Table 3.4.1-3, unemployment in Nuiqsut was 10 percent in 1998. While Nuiqsut had a similar unemployment rate to Barrow (10 percent) and somewhat higher than Anaktuvuk Pass, Nuiqsut had a much higher underemployment rate than any of the communities and the NSB as a whole. Many of the job opportunities in Nuiqsut are provided by the Kuukpik Native Corporation, the NSB, state employment associated with the school, and the village store. In 1998, 176 residents were employed out of a total workforce (age 16 and over) of 264. The highest number of jobs is in government (city, borough, state, and federal), with 91 jobs identified in the 2000 census. The next largest job category is in construction, with 53 jobs.

As a result of current development of the Alpine Field, Nuiqsut has received a number of economic benefits and employment opportunities, including the following:

Contracts totaling approximately $250 million were awarded to Kuukpik (the Nuiqsut Village Corporation) and its joint-venture businesses. CPAI currently has contracts with several Kuukpik Corporation joint ventures, including Nanuq (construction); Kuukpik/Arctic Catering (catering); Kuukpik/Fairweather (seismic); Kuukpik/LCMF (surveying); Kuukpik/Carlisle (trucking), and Kuukpik/Purcell (security).

As of June, 2003 four Nuiqsut residents were working full-time in the Alpine Field operations group and six full-time in the construction group.

Seasonal work opportunities have been made available to residents of Nuiqsut and other communities in the area. During the first 5 months of 2003, CPAI reported that it employed approximately 100 local residents, predominantly Inupiat.

Ongoing jobs are held by Nuiqsut residents, including one monitor for the CPAI air quality/meteorology monitoring station in Nuiqsut; two ice road monitors (during the winter ice road season), and two environmental studies assistants (typically subsistence representatives during the summer.) “Stickpickers” are also employed during the summer to collect debris at the edge of production pads and along ice road routes.

Increased economic activity within Nuiqsut related to ongoing Alpine Field operations includes increased occupancy at the Kuukpik Hotel, an office space lease from the City of Nuiqsut for the CPAI liaison, and storage of ice road equipment.

BARROW

Barrow, the northernmost community in North America, is the seat for the NSB. From 1975 to 1985, Barrow experienced extensive social and economic transformations. The NSB CIP projects stimulated a boom in the Barrow economy and an influx of non-Natives to the community. Between 1980 and 1985, Barrow’s population grew by 35.6 percent (Kevin Waring Associates 1989). Inupiat women entered the labor force in the largest numbers ever known, and they achieved positions of political leadership in newly formed institutions. The proportion of Inupiat women raising families without husbands also increased during this period, a noticeable alteration in a culture where the extended family, operating through interrelated households, is salient in community social organization (Worl and Smythe 1986). During this same period, the social organization of the community became increasingly diversified, with the proliferation of formal institutions and the large increase in the number of different ethnic groups. As a consequence of the changes it has already sustained, Barrow could be more capable of absorbing additional change resulting from oil exploration and development than would smaller, homogeneous Inupiat communities such Nuiqsut, Atqasuk, and Anaktuvuk Pass.

The 2000 population in Barrow was 4,581. The largest component of the population (57.2 percent) is Alaska Native/Native American. Of the four communities in proximity to the Plan Area, Barrow has the largest non-Native population segment. Figure 3.4.1.7-1 shows the population growth trend for the period from 1960 through 2000. From 1980 to 2002, Barrow’s population grew at an annual rate of 5 percent.

Table 3.4.1-1 shows selected socioeconomic characteristics for Barrow. In 2000, the average per capita income for Barrow was $22,902, roughly equivalent to the State of Alaska as a whole and approximately 10 percent greater than the rest of the NSB. The median age for Barrow residents was 28.8, approximately 5 years younger than the state average but similar to the NSB as a whole. Average household size was 3.27, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 7.7 percent, and 16.9 percent of households earned less than $25,000 per year. The household poverty rate was less that the NSB average but more that the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Barrow is the economic hub of the NSB. In 2000, total employment in Barrow was 1,986 jobs. State, local, and federal government workers accounted for 1,176 jobs, or 59.2 percent of the total. As shown in Table 3.4.1-3, unemployment in Barrow was 10 percent in 1998. While Barrow had an unemployment rate similar to that of Nuiqsut (10 percent) and somewhat higher than Anaktuvuk Pass, it had a much lower underemployment rate than Atqasuk and the NSB as a whole.

ATQASUK

Atqasuk is a traditional Inupiat village approximately 60 miles south of Barrow on the Meade River. Atqasuk’s inland location dictates its subsistence preferences, with caribou and fish being the primary subsistence resources. Social ties between Barrow and Atqasuk remain strong, with men from Atqasuk traveling to Barrow to join bowhead-whaling crews. Atqasuk has largely avoided the rapid social and economic changes experienced by Barrow and Nuiqsut brought on by oil development activities, but future change could accelerate as a result of oil exploration and development in the Northwest National Petroleum Reserve-Alaska Planning Area.

The community was repopulated after declining to zero residents in the 1970 census. In 1980, there were 107 residents; the population increased to 216 residents in 1990 and 228 in 2000. Figure 3.4.1.7-1 shows population growth at a rate similar to that of Barrow and Nuiqsut during the period of 1980 to 1990. However, after 1990, growth slowed considerably.

Table 3.4.1-1 shows selected socioeconomic characteristics for Atqasuk. In 2000, the average per capita income for Atqasuk was $14,732, approximately two-thirds that of the State of Alaska and the rest of the NSB. The median age for Atqasuk residents was 26.3, approximately 6 years younger than the state average but similar to the NSB as a whole. Average household size was 4.15, which was larger than the state average but about the same as the NSB. The percentage of households in poverty status was 25 percent, and 19.6 percent of households earned less than $25,000 per year. The household poverty rate was three times the NSB average and four times the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Atqasuk had the smallest labor force of the four communities, with only 98 workers. Both the unemployment and underemployment rates in the workforce were the highest of the four communities. Unemployment was 40 percent in 1998 compared to the NSB average of 16 percent, and underemployment was 44 percent.

ANAKTUVUK PASS

Anaktuvuk Pass is a traditional Inupiat village, situated in the central Brooks Range on a divide between the John River and the Anaktuvuk River. Its elevation is 2,200 feet. The community has limited employment opportunity because of its remote location. A high proportion of residents participate in subsistence activities, and caribou is the primary source of meat. Population figures before 1950 show no residents in Anaktuvuk Pass. In 1949, several families returned to repopulate the community.

Table 3.4.1-1 shows selected socioeconomic characteristics for Anaktuvuk Pass. In 2000, the average per capita income for Anaktuvuk Pass was $15,283, approximately two-thirds that of the State of Alaska and the rest of the NSB. The median age for Anaktuvuk Pass residents was 25.7, approximately 6 years younger than the state average but similar to the NSB as a whole. Average household size was 3.36, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 3.2 percent, and 11.1 percent of households earned less than $25,000 per year. The household poverty rate was less than one-half the NSB average and approximately one-half the statewide average. The percentage of households earning less than $25,000 was significantly lower than both the statewide and NSB averages.

Total employment (full-time, temporary, and part-time) in Anaktuvuk Pass is 91 out of the potential workforce of 147. The largest employment category is for government workers, with 69 jobs.

3.4.2 Regional Economy

The economic characteristics of the communities closest to the Plan Area have been described in Section 3.4.1 Socio-Cultural Resources. This section describes the relationship of the oil and gas industry to the North Slope economy, the economy of the State of Alaska, and the nation's economy.

3.4.2.1 Role of Oil Production

Economic activity generated by North Slope crude oil production, transportation, and marketing is the largest sector of the North Slope economy, the second largest sector of the Alaskan economy (after government expenditures), and is an essential element of the national economy.

Oil production from North Slope fields offsets imports of foreign oil and generates substantial tax revenues and royalties for federal and state governments. In addition, North Slope oil supports the marine tanker transportation sector of the economy, since the vast majority of Alaskan oil is delivered to west coast United States ports for refining and distribution.

The United States was able to satisfy domestic demand for oil from domestic supplies until 1950, when the country became a net oil importer. With the continued growth in crude oil demand, dependence on foreign oil has increased; the United States now relies on imported sources for more than 60 percent of domestic demand from other countries (DOE 2001c). The continued development of domestic sources of oil is a national policy.

North Slope production has regularly constituted more than 15 percent of U.S. domestic crude production. Throughout the late 1980s, the fields contributed more than 20 percent, peaking at approximately 25 percent in 1988 (DOE 2001c). Dependence on foreign oil also has implications for the nation's balance of trade with the rest of the world. North Slope production has reduced the U.S. balance of trade deficit by an average of 21 percent over the period 1977 to 2001, reducing the overall trade deficit by an average of 12 percent, with approximately $446 billion (in 2000 dollars) saved on the cost of U.S. oil imports (DOE 2001c).

Oil production is the dominant revenue-producing sector of the economy of the North Slope. Revenue returned to the NSB and local communities from oil production plays a significant role in the fiscal support of these local governments. Development of the ASDP could increase revenues and employment associated with this sector or extend current levels of revenue and employment into future years. This section describes the relationship of this industry to the state and North Slope economy.

The effects of oil production on the regional and statewide economy are primarily driven by the rate of production and transportation. Alaska state oil exports are dominated by production from the North Slope fields. Minor production also occurs in Cook Inlet, but only averaged 2.5 percent of total Alaska oil production between 1990 and 2000 (Alaska Department of Revenue 2002). Production from the North Slope oilfields and the transportation of crude to Valdez through the TAPS began in 1977. Production and transportation peaked at 2.038 MMbbl per day in 1988; it continues at an average daily production rate of 1.045 MMbbl, approximately 51 percent of its 1988 peak level (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-1).

Oil production and the development of new reserves is highly sensitive to crude oil prices. After peaking in early 1981 at $70 bbl in 2000 dollars ($37/bbl in 1981 dollars), oil prices have fluctuated, reaching an all-time low in 1998 of $13/bbl (in 2000 dollars; $12/bbl in 1998 dollars), 18 percent of the 1981 peak level (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-1).

Oil prices have rebounded slightly since1998 and currently stand at $29/bbl (October 2003).

3.4.2.2 Revenues

Activities of the oil and gas industry provide revenues to federal, state, and regional governments, as well as direct and secondary employment. The sources, and in some cases, the amounts of these revenue streams are listed below.

FEDERAL GOVERNMENT

- Corporate Income Taxes – TAPS pipeline owners, oil producers, and oil industry service companies
- Royalties – oil producers
- Estimated Revenues – Total federal Outer Continental Shelf (OCS) revenues for the Beaufort Sea, including bonuses, royalties, and rents were 1995 – $1.1 million; 1996 – $16.1 million; 1997 – $1.1 million; 1998 – $7.4 million; 1999 – $1.4 million; and 2000 – $1.4 million. The 1999 National Petroleum Reserve-Alaska lease sale resulted in first-year bonus bids of $114.6 million and the 2002 lease sale in the Northeast National Petroleum Reserve-Alaska resulted in $31.9 million in first-year bonus bids for the federal government. The 2003 MMS lease sale for the Beaufort Sea resulted in total lease revenue of $8.9 million.

STATE GOVERNMENT

- Production Severance Tax – oil producers
- Property Tax – oil producers
- Income taxes – oil producers and oil industry service companies
- Royalties, bonuses, lease payments – oil production on state leases
- Distribution of OCS revenues (rents, bonuses, royalties, escrow funds, and settlement payments) – federal government (OCS distribution from Beaufort Sea Lease Sales were 1995 – $9.4 million; 1996 – $9.5 million; 1997 – $17.3 million; 1998 – $13.6 million; 1999 – $14.7 million; 2000 – $13.7 million; and 2001 – $13.4 million.)

NORTH SLOPE BOROUGH

PROPERTY TAX – OIL PRODUCERS WITH LEASES ON NSB LANDS

The fiscal health of Alaska is closely tied to the fortunes of the oil industry in the state, although that dependence is declining. The balance of general fund revenues comes from corporate income taxes, fees, and licenses. Currently no state income tax or sales tax is levied in Alaska.

State revenues from oil industry activity represented 47 percent of total state revenue in 2002 and are projected to be 35 percent in 2003, as shown in Table 3.4.2-1. This is consistent with the oil industry contribution to state revenues over the past decade. The percent contribution in 1990 was 43 percent, and in 2000 it was 34 percent (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-7.) However, in the period of 1980 to 2000, the oil industry contribution to state revenues has fallen at an average annual rate of -2.9 percent from a high of 82 percent to 34 percent, reflecting the overall decline in oil production.

TABLE 3.4.2-1 ALASKA STATE REVENUES (IN MILLIONS OF DOLLARS)

Revenue Source	Actual FY 2002	Projected FY 2003
Oil revenue	$1,676	$1,860
Investment revenue	$442	$260
Other revenue	$756	$802
Federal revenue	$1,572	$2,322
Total state revenues	$3,562	$5,244
Oil revenue percent	47 %	35 %

Source: Fall 2002 Revenue Sources Book, Alaska Department of Revenue, Tax Division, November 2002.

General purpose expenditures by state government have tended to exceed revenues collected from the various sources available, meaning that the state has had to draw on cash surpluses accumulated from oil revenues in earlier years (TAPS Owners 2001a). As revenues from oil production fell with declining production and lower world oil prices, the state established the Constitutional Budget Reserve Fund (CBRF) in 1991 to cover year-to-year deficits. The CBRF consists of settlements from oil and gas tax and royalty disputes. In recent years, the gap between state revenues and the budget expenditures has been filled by withdrawals from the CBRF, and those withdrawals are depleting this reserve fund.

While oil industry revenues continue to remain a significant source of income for the state, the reduction in these revenues has been partially offset in some years by the contribution of earnings from the investment of oil revenues. These investment earnings have grown at an average of almost 15 percent each year since 1980. Also offsetting the loss of oil revenues has been the growth in federal grants to Alaska, which increased at an annual average rate of 3.1 percent between 1980 and 2000, and non-oil revenues, which increased at an annual rate of 2.2 percent over the same period. Overall, the state budget grew at an annual rate of 1.4 percent between 1980 and 2000.

NSB revenues from 1992 through 2001 have varied between a low of $292 million in 2000 and a high of $320 million in 1996. Revenues by year were (NSB 2001):

- 1992 – $321 million
- 1993 – $331 million
- 1994 – $311 million
- 1995 – $313 million
- 1996 – $320 million
- 1997 – $315 million
- 1998 – $331 million
- 1999 – $291 million
- 2000 – $282 million
- 2001 – $298 million

Sources of revenue are listed in Table 3.4.2-2. The largest share of NSB revenues comes from general property taxes, mostly from oil production-related real property. The real property assessed valuation of NSB property has steadily declined from 1992 ($11.5 billion) through 2001 ($9.4 billion) as a result of depreciation of assets. The NSB has the highest per capita level of bonded indebtedness in Alaska by far, at $59,439 per capita (ADCED 2003). The borough with the next highest per capita bonded indebtedness is the Northwest Arctic Borough, with $5,035 per capita. The revenue figures shown in Table 3.4.2-2 include intergovernmental revenues, such as school funding.

The largest share of revenues to the NSB comes from general property taxes. In 2001, more than 94 percent of total property tax revenues were attributed to oil and gas-related property (ADEC, Alaska Taxable, 2001).

TABLE 3.4.2-2 NORTH SLOPE BOROUGH GENERAL GOVERNMENT REVENUES BY SOURCE: 2001

Category	Annual Revenue
General property tax	$201,963,000
General sales/economic impact assistance	$4,500,000
Intergovernmental revenues	$32,816,000
Charges for service	$9,726,000
Miscellaneous	$49,505,000
Total general government revenues	$298,510,000

Source: Comprehensive Annual Financial Report of the North Slope Borough, Alaska, July 1, 2000 – June 30, 2001.s

3.4.2.3 North Slope Borough Government Expenditures

Including debt service, capital programs, and transfers, state expenditures grew at an average rate of 1.9 percent during the period between 1980 and 2000, although overall expenditures fell in the 1990s. Expenditures per capita have fallen significantly since 1990 and are currently lower than they were in 1980, as population growth in the state has outpaced the ability of the state to fund expenditure programs. Nevertheless, state expenditures per capita still are currently the highest in the nation, primarily because the harsh climate, low population density, and the inaccessibility of many communities make the services provided by state agencies very costly. The largest component of state government expenditures is social services, which grew at an average rate of 11 percent between 1980 and 2000 and now constitutes 45 percent of overall state expenditures. Expenditures in other areas, such as public safety, have grown fairly rapidly, while state funding of other areas, such as transportation and environment and housing, have fallen.

NSB expenditures have remained relatively constant during the period from 1992 ($300 million) through 2001 ($320 million).

3.4.2.4 Employment and Personal Income

A profile of Alaska’s economy is presented on Figure 3.4.2.4-1, State of Alaska 2001 Employment by Sector. Compared with Alaska’s early days, the state’s current economy is more diverse and mature, with a large proportion of overall employment in the service sector. The largest employment sector shown on Figure 3.4.2.4-1 is the government sector, with 27.1 percent of the 290,000 total wage and salary jobs for 2001. The government sector comprises federal employment (16,800 jobs), state employment (22,900 jobs), and local government (38,800 jobs). The service sector is the next largest, with 73,000, 25.2 percent of total jobs. Trade is the third largest employment sector with 58,200, or 20.1 percent. The fourth largest employment sector is the combined transportation/communications/utilities, which accounts for 28,000 jobs, or 9.6 percent of total employment. Construction contributes 5.1 percent. Manufacturing and the combined financial/insurance/real estate sectors contribute 4.7 percent and 4.4 percent, respectively, to total employment. Mining, which is predominantly oil and gas extraction, is the smallest sector and accounts for 11,200 jobs, or 3.9 percent of the total (ADOL 2003b).

While mining (primarily oil and gas extracting) is one of the smallest sectors of the economy, it has the highest hourly earnings rate. In 2002, average hourly wages for mining were $28.37 per hour, compared with $27.67 per hour in construction, $21.37 per hour for Transportation/Communication/Utilities, $16.77 per hour for Manufacturing, $14.70 per hour for Trade, and $18.58 per hour for Finance/Insurance/Real Estate (ADOL 2003c).

In 2001, Alaska’s per capita income was $30,936, placing fifteenth in the national ranking with all states (Bureau of Economic Analysis 2003). During the past several decades, Alaska’s per capita incomes have declined relative to those of other states. In 1960, Alaska’s per capita income ($2,815) was fourth among all states. In 1980, Alaska’s per capita income ($13,875) was first in the nation. By 1990, Alaska’s per capita income ($21,073) had declined to ninth among all states (ADOL 2000).

Employment and income data for the NSB and the four communities in or near the Plan Area were discussed in Section 3.4.1.

3.4.3 Subsistence Harvest and Uses

3.4.3.1 Introduction

This section describes subsistence harvest and uses in the ASDP Area. The methodology and sources of data, the regulatory definition of “subsistence,” and the importance and context of subsistence to past and present resource users are also discussed.

The methodology for evaluating subsistence resource use employed in this analysis includes a review of available literature and data related to communities using the Plan Area for subsistence or using wildlife resources that spend time in the Plan Area.

Data sources for this section include subsistence resource reports published by the NSB Department of Wildlife Management and the ADF&G Division of Subsistence, published and unpublished harvest data from these agencies, technical reports published by the MMS, the general ethnographic and historical literature, relevant correspondence between Inupiat organizations and agencies (Kuukpik Corporation 2002), and the results of field interviews. For quantitative measures of use, the best available and/or most recent subsistence harvest data were acquired from ADF&G, NSB, and MMS reports. These data include information about the number of and amount of subsistence species harvested, the location and timing of subsistence harvests, the extent of past and present subsistence land use, and the cultural importance of subsistence uses. Historical and ethnographic literature from academic and historical sources, published and unpublished, provides additional qualitative data about the use and social context of subsistence resources in the recent past. Fieldwork information derived from key informant interviews provides additional information regarding subsistence resource use and harvest areas in the present and the recent past.

As subsistence is a contentious issue and land ownership in the Plan Area is state, federal and Native, definitions of subsistence used by each of these entities is provided below. Both federal and state statutes govern subsistence activities in Alaska. Under state law “subsistence uses means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural [sic] area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption, and for customary trade, barter, or sharing for personal or family consumption.” (A.S. 16.05.940[32])

Under federal law, “subsistence uses means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.” (ANILCA Title VIII Section 803)

The Alaska Federation of Natives (AFN) describes subsistence as “the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska’s Native peoples and which continue to flourish in many areas of the state today. Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, tribal cultures, and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans. Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical.” Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

Subsistence is part of a rural economic system, called a “mixed, subsistence-market” economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (ADF&G 2000). Fishing and hunting for subsistence provide a reliable economic base for many rural regions. Domestic family groups who have invested in fish wheels, gill nets, motorized skiffs, and snowmobiles conduct these important activities. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production), but is focused on meeting the self-limiting needs of families and small communities. Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, and/or wages from public sector employment, construction, fire fighting, oil and gas industry, or other services) provides the means to purchase the equipment, supplies, and gas used in subsistence activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the North Slope Inupiat. These customs and traditions encompass sharing and distribution networks, cooperative hunting, fishing, and ceremonial activities. Subsistence fishing and hunting are important sources of non-traditional employment and nutrition in almost all rural communities. The ADF&G estimates that the annual wild food harvest in the arctic area of Alaska is approximately 10,507,255 pounds, or 516 pounds per person per year. Subsistence harvest levels vary widely from one community to the next. Sharing of subsistence foods is common in rural Alaska (ADF&G 2000).

3.4.3.2 Patterns of Subsistence Resource Use

Communities whose residents harvest or rely on subsistence resources in the ASDP Area include Barrow, Nuiqsut, Atqasuk, and Anaktuvuk Pass. Barrow and its environs have a long history of use by Inupiat hunters, with numerous archaeological deposits attesting to a long and continuous occupation. Atqasuk and Nuiqsut represent traditional subsistence use areas and were reestablished more recently as sedentary villages as people who had moved to Barrow from these areas before World War II returned to places where they had historic connections. A large part of these connections was knowledge of the land and subsistence resource availability in those formerly used areas (IAI 1990). This section describes subsistence land uses for the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut for historic and contemporary times.

NUIQSUT SUBSISTENCE ACTIVITIES

A diverse seasonal abundance of terrestrial mammals, fish, birds, and other resources is available in the immediate area surrounding Nuiqsut. Traditional subsistence activities in the Nuiqsut area revolved around caribou, marine mammals, and fish. Moose, waterfowl, and furbearers were secondary but important supplementary resources. Nuiqsut’s location on the Colville River, some 35 miles upstream from the Beaufort Sea, has been a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (ADCED 2003). The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish (Craig, 1989).

Twenty-seven families from Barrow permanently resettled Nuiqsut in 1973. The site of Nuiqsut was formerly a place where Inupiat people gathered to trade and fish, maintaining connections between the Nunamiut of the inland areas and the Taremiut of the coast (Brown 1979). ANCSA allowed Inupiat from Barrow who wished to live in a more traditional fashion to select the site for resettlement, and many of those who moved there had some family connection to the area (IAI 1990). Easy access to the main channel of the Colville River for fishing, hunting, and ease of movement between upriver hunting sites and downriver whaling and sealing sites was the primary reason for selection of the site (Brown 1979).

Nuiqsut is one of 10 Alaska Eskimo whaling communities. Many of those who resettled Nuiqsut were experienced whalers and crew who remembered past whale harvests before the temporary abandonment of the settlement (IAI 1990). Nuiqsut whale hunting is based from Cross Island, approximately 70 miles northeast of Nuiqsut and approximately 15 miles from West Dock on the west side of Prudhoe Bay. Nuiqsut whalers travel approximately 100 miles from Nuiqsut to the Cross Island whaling camp. Nuiqsut whaling occurs in the fall when the whales migrate closer to shore, because the spring migration path is too distant from shore for effective hunting with small boats. Nuiqsut residents can also participate in Barrow’s spring whale hunt through close family ties in that community (Fuller and George 1999).

Nuiqsut is situated closer to current and foreseeable areas of petroleum development than any other community on the North Slope. This development has deterred subsistence resource users from hunting, fishing, and gathering in their former traditional harvest areas east of the Colville River and at coastal areas such as Oliktok Point (Fuller and George 1999; IAI 1990). According to Circumpolar Research Associates [(CRA) 2002)], during 2000, unemployment appears to have increased, reinforcing the importance of subsistence resource harvests for local residents who have lived there for more than 10 years (since Nuiqsut residents who lived in the community the longest time consumed larger quantities of traditional foods [CRA 2002]). However, a determinative link between household wage income and household subsistence productivity has not been demonstrated; the former was dependent on education levels, and the latter on the number of capable producers in the household (Pederson et al. 2000).

CONTEMPORARY SEASONAL ROUND

The seasonal availability of many important subsistence resources directs the timing of subsistence harvest activities. Fishing occurs year-round, but is most common from break-up (June) through November (Fuller and George 1999). Beginning in March, Nuiqsut residents hunt ptarmigan. Waterfowl hunting begins in the spring, and hunters typically harvest ducks and geese while participating in other subsistence activities such as jigging for burbot or lingcod (IAI 1990). Caribou are harvested primarily during the late summer and fall months but are hunted year-round. Moose hunting takes place in August and September in boat-accessible hunting areas south of Nuiqsut (Fuller and George 1999). August is the primary harvest month for caribou and moose, because water levels are right for traveling upriver or on the coast by boat, and the animals are usually in their best condition. Many Nuiqsut residents participate in subsistence fishing. If weather and ice conditions permit, summer net fishing at fish camps begins in June or July. Bowhead whaling usually occurs in September when the whales migrate closer to the shore. Nuiqsut hunters harvest few polar bears, but if they are harvested it is often during the fall whaling season. Gill netting at campsites is the most productive between October and mid-November. Jigging for grayling and burbot also occurs in the fall. Trappers pursue wolves and wolverines through the winter months, primarily in March and April. Trapping can be undertaken anytime during the winter; however, most hunters avoid going out in the middle of winter because of poor weather conditions and lack of daylight (IAI 1990). Table 3.4.3-1 summarizes Nuiqsut's annual cycle of subsistence activities.

TABLE 3.4.3-1 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – NUIQSUT

	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	■	□	▒	▒	▒	▒	▒	■	■	■	▒	■
Birds/Eggs	▒	▒	▒	▒	▒	■	■	■	■	▒	▒	■
Berries	□	□	□	□	□	□	□	▒	▒	■	□	□
Moose	□	□	□	□	□	□	□	□	▒	■	▒	□
Caribou	▒	■	▒	▒	■	■	■	▒	■	■	▒	■
Furbearers	▒	▒	▒	▒	▒	■	▒	□	□	□	□	▒
Polar Bear	■	▒	▒	▒	▒	▒	▒	□	□	□	▒	▒
Seals	▒	▒	□	□	▒	■	▒	■	■	■	■	▒
Bowheads	□	□	□	□	□	□	□	□	□	▒	■	□

Source: Impact Assessment Inc. 1990; Research Foundation of the State University of New York 1984; SRB&A 2003

Notes:

□	No to Very Low Levels of Subsistence Activity
▒	Low to Medium Levels of Subsistence Activity
■	High Levels of Subsistence Activity

SUBSISTENCE HARVESTS

The ADF&G collected subsistence harvest data for Nuiqsut in 1985 and 1993. The ADF&G chose 1993 as the most representative year for subsistence harvest data in Nuiqsut (Tables 3.4.3-1 and 3.4.3-2). Nuiqsut's total annual subsistence harvests ranged from 160,035 pounds in 1985 to 267,818 pounds in 1993 (Table 3.4.3-2). The 1993 harvest of 742 pounds per capita of wild resources represents approximately two pounds per day per person in the community. In 1985, fish and land mammals accounted for 86 percent of Nuiqsut's subsistence harvest and marine mammals contributed eight percent. In 1993, fish, land mammals, and marine mammals accounted for approximately one-third each (Table 3.4.3-2). The importance of subsistence to Nuiqsut residents is further reflected in the high participation rates in households that use (100 percent), harvest (90 percent), try to harvest (94 percent), and share (98 percent) subsistence resources (Table 3.4.3-2).

TABLE 3.4.3-2 NUIQSUT SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES FOR 1985, 1992, AND 1993

	Percentage of Households					Estimated Harvest				
Resource	**Use**	**Try to Harvest**	**Harvest**	**Receive**	**Give**	**Number**	**Total Pounds**	**Mean HH Pounds**	**Per Capita Pounds**	**% Total Harvest**
1985										
All Resources	100	98	98	100	95		160,035	2,106	399	100
Fish	100	93	93	78	83	68,153	70,609	929	176	44
Salmon	60	43	40	23	23	441	1,366	18	3	1
Non-Salmon	100	93	93	75	83	67,712	69,243	911	173	43
Land Mammals	100	95	93	70	85	1,224	67,866	893	169	42
Large Land	98	90	90	70	80	536	67,621	890	169	42
Small Land	65	63	58	13	23	688	245	3	1	<1
Marine Mammals	100	48	23	100	30	59	13,355	176	33	8
Birds and Eggs	98	95	95	60	80	3,952	8,035	106	20	5
Vegetation	38	50	18	20	10		169	2	0	0
1992										
All Resources							150,196	1,430	359	100
Fish							51,955	495	124	35
Land Mammals							41,503	395	99	28
Marine Mammals							52,749	502	126	35
Birds and Eggs							3,924	37	9	3
Vegetation							65	1	0	
1993										
All Resources	100	94	90	98	92		267,818	2,943	742	100
Fish	100	81	81	94	90	71,897	90,490	994	251	34
Salmon	71	45	36	47	39	272	1,009	11	3	<1
Non-Salmon	97	79	79	90	87	71,626	89,481	983	248	33
Land Mammals	98	77	76	94	82	1,290	87,390	960	242	33
Large Land	98	76	74	92	82	691	87,306	959	242	33
Small Land	53	45	42	18	27	599	84	1	0	<1
Marine Mammals	97	58	37	97	79	113	85,216	936	236	32
Birds and Eggs	90	77	76	69	73	3,558	4,325	48	12	2
Vegetation	79	71	71	40	27		396	4	1	0

Sources: ADF&G Community Profile Database Version 3.11, March 2001 (for 1985 and 1993); Fuller and George 1999 (for 1992); SRB&A 2003.

In 1985, Nuiqsut did not land any bowhead whales. The community harvested two bowheads in 1992 and three bowheads in 1993. Caribou, whitefish, and bowhead whales contributed 88 percent of Nuiqsut's annual subsistence harvest in terms of edible pounds in 1993 (Table 3.4.3-3).

In 1992, marine resources dominated the subsistence harvest (35.1 percent of the total harvest), largely as the result of a successful bowhead hunt at Cross Island (Tables 3.4.3-2 and 3.4.3-3) (Fuller and George 1999). Other harvested marine mammals included polar bear and bearded and ringed seals. Fish (broad whitefish and least and arctic cisco) comprised 34.6 percent of the total harvest for Nuiqsut in 1992. Approximately 28 percent of the total harvest in 1992 was land mammals (caribou and moose). The harvest of birds (geese and eiders) was approximately 3 percent of the total harvest in 1992. The highest Nuiqsut household participation rates were in fishing, caribou hunting, moose hunting, and bear hunting (Fuller and George 1999).

The data for 1994 to 1995, collected by the NSB Division of Wildlife, were presented in a different format from that used by ADF&G (Brower and Hepa 1998). This was an exceptional year in that Nuiqsut crews harvested no whales. Caribou contributed 58 percent of edible pounds of wild foods for the sampled period, with fish contributing 30 percent, moose and birds each 5 percent, marine mammals 2 percent, and wild plant foods less than 1 percent of edible pounds harvested (Brower and Hepa 1998, p. 15). Nuiqsut residents participating in subsistence harvest activities were in the majority, with 66 percent successful, unsuccessful, or out hunting at the time of the interviews, 21 percent not attempting to harvest, and the balance not wishing to be interviewed (5 percent), out of town (7 percent), or unable to be contacted (1 percent) (Brower and Hepa 1998). Eighty-seven percent of harvest instances resulted in resource sharing (Brower and Hepa 1998).

CONTEMPORARY SUBSISTENCE USE AREAS

Pedersen documented Nuiqsut "lifetime" (Pedersen 1979) and 1973 to 1986 land uses areas (Pedersen, in prep.) (Figure 3.4.3.2-1). Brown (1979) and Hoffman et al. (1988) also documented Nuiqsut subsistence use areas in the 1970s, which are incorporated within the lifetime use areas depicted in Pedersen (1979). Comparing Pedersen's Nuiqsut lifetime use areas (1979) and other earlier documentation of Nuiqsut subsistence use areas (Brown 1979; Hoffman et al. 1988) with Pedersen's (in prep.) 1973 through 1986 subsistence land uses documentation, as depicted on Figure 3.4.3.2-1, shows Nuiqsut resource harvesters using a larger area offshore, a larger area to the west including northwest to Barrow, going to the south to Anaktuvuk Pass, and changes around industrial development to the east. It should be noted that when the 1970s research (for example, Pedersen 1979, and Brown 1979) was conducted, Nuiqsut had only been resettled for a few years (since 1973) and hunters "were relearning the land to a large extent" (IAI 1990) and were not using the entire area formerly used by people originally from the Colville River Delta. Thus, Pedersen (in prep.) shows a larger Nuiqsut subsistence use area for 1973 through 1986 than either Pedersen (1979) shows for lifetime use areas or Brown (1979) depicts for his limited interviews. This change likely reflects Pedersen's continuing research, as well as Nuiqsut hunters' expanding use as residents resettled their traditional area.

Stephen R. Braund & Associates (SRB&A) conducted 21 interviews with subsistence resource users in Nuiqsut in June and July of 2003. SRB&A interviewed a variety of currently active resource users including persons of both genders and several ages, from young hunters starting out, through increasingly active and productive middle-aged hunters, to the active elders who still harvest subsistence foods and train the younger hunters. Figure 3.4.3.2-2 shows the recent (last ten years) subsistence use areas for all resources for the 21 Nuiqsut residents interviewed in 2003.

The 2003 information and the earlier documented Nuiqsut use areas depict a similar use area with some variation. The 2003 interviews did not focus on the area west of Barrow and hence did not capture the travel between Nuiqsut and Barrow and associated hunting. The western extent is similar, with some minor variation that likely reflects the different hunters that were interviewed. During the 2003 interviews, it became apparent that southern extent of Nuiqsut's land uses extended beyond the map used for the interviews. Some formerly used areas depicted in lifetime use area maps and the 1973 through 1986 use areas (for example, the Prudhoe Bay area) are perceived by some residents as being no longer accessible and by many residents as being undesirable because of industrial development, as noted in Pedersen et al. (2000), SRB&A interviews (2003), scoping testimonies, and in ADF&G (2001, Issues section).

TABLE 3.4.3-3 SELECTED NUIQSUT SUBSISTENCE HARVESTS FOR 1985, 1992, 1993, AND 1994-1995

	Estimated Harvest				
Resource	**Number**	**Total Pounds**	**Mean HH Pounds**	**Per Capita Pounds**	**% of Total Harvest**
1985					
Caribou	513	60,021	790	150	38
Whitefish	58,733	59,701	786	149	37
Bowhead[1]	0	7,458	98	19	5
Geese	1,345	6,045	80	15	4
Moose	13	6,650	88	17	4
Seals	57	4,431	58	11	3
Burbot	669	2,675	35	7	2
Char	1,083	3,060	40	8	2
Grayling	4,055	3,650	48	9	2
1992					
Bowhead	2	48,715	464	117	32
Caribou	278	32,551	310	78	22
Arctic cisco	22,391	22,391	213	54	15
Broad whitefish	6,248	15,621	149	37	10
Moose	18	8,835	84	21	6
1993					
Caribou	672	82,169	903	228	31
Bowhead	3	76,906	845	213	29
Whitefish	64,711	77,671	854	215	29
Seals	109	8,310	91	23	3
Grayling	4,515	4,063	45	11	2
Moose	9	4,403	48	12	2
Burbot	1,416	5,949	65	16	2
Char	618	1,748	19	5	1
Geese	1,459	2,314	25	6	1
1994-1995					
Caribou	258				
Whitefish	14,532				
Seals	24				
Grayling	462				
Moose	5				
Burbot	91				
Char	8				
Geese	457				
Berries	14				

Source: ADF&G Community Profile Database Version 3.11, March 2001 (for 1985 and 1993); Fuller and George 1999 (for 1992); Brower and Opie 1997 (for 1994-1995); SRB&A 2003.

Notes: [1] No bowhead were harvested by Nuiqsut in 1985. Pounds of bowhead in 1985 are from receiving shares from other communities.

The 2003 information and the earlier documented Nuiqsut use areas depict a similar use area with some variation. The 2003 interviews did not focus on the area west of Barrow and hence did not capture the travel between Nuiqsut and Barrow and associated hunting. The western extent is similar, with some minor variation that likely reflects the different hunters that were interviewed. During the 2003 interviews, it became apparent that southern extent of

Nuiqsut's land uses extended beyond the map used for the interviews. Some formerly used areas depicted in lifetime use area maps and the 1973 through 1986 use areas (for example, the Prudhoe Bay area) are perceived by some residents as being no longer accessible and by many residents as being undesirable because of industrial development, as noted in Pedersen et al. (2000), SRB&A interviews (2003), scoping testimonies, and in ADF&G (2001, Issues section).

CARIBOU USE AREAS

Harvest location data for caribou collected by the NSB (Brower and Hepa 1998; NSB 2003) and ADF&G (2001, 2003) and hunting area interviews conducted in Nuiqsut for this project indicate that there are several primary harvest areas for caribou (*tuttu*) (Figure 3.4.3.2-3). Going north, these harvest locations include the Nuiqsut area, the Colville River Delta, the Nigliq Channel, and the Fish and Judy creeks area. To the south of Nuiqsut, the Colville River provides access to areas and sites such as Itkillikpaat, Ocean Point, Itkillik River, Umiat, and the confluences of the Anaktuvuk and Chandler rivers. These areas are usually associated with Traditional Land Use Inventory (TLUI) sites, cabins, camps, and native allotments with harvest locations for other species nearby. These harvest locations can be used in winter (October through May), summer (June through September), or both, and they can be accessed by foot, boat, all-terrain vehicle, and snowmobile.

Figure 3.4.3.2-3 shows the recent harvest areas of interviewed hunters for caribou, and Figure 3.4.3.2-4 shows the winter and summer caribou hunting areas. Summer hunting is done by boat after the river ice breaks up, and hunters proceed along the coast from Smith Bay east to the Sagavanirktok River, including Oliktok Point, several barrier islands, and in all channels of the Colville River Delta, Fish Creek, and Judy Creek. Hunters also go south on the Colville River beyond Umiat, passing Itkillikpaat, Ocean Point, Signal Hill, and Umirak en route. These trips upriver are taken by boat in the summer, in the fall when moose and caribou can be harvested, and by snowmobile in the winter in pursuit of caribou and furbearers. Nuiqsut hunters also travel up the Itkillik, Chandler, and Anaktuvuk rivers by boat and snowmobile. There are many camps and cabins in the area of Fish and Judy creeks, throughout the Colville River Delta, and up the Colville River to the south that are used for summer and winter caribou hunting. These camps often have drying racks and ice cellars for processing and storing harvested game, as well as caches of survival gear and supplies.

Cumulative Nuiqsut caribou harvests by month for 1993, 1994 through 1995, 2000, and 2001 are shown on Figure 3.4.3.2-5. There are monthly and seasonal differences in the proportion of caribou harvested, with summer (defined as the open water period, including June, July, August, and September) harvests providing approximately 60 percent of the harvested caribou. For the four data years, July (23 percent) and August (24 percent) are the months with the greatest cumulative caribou harvests. According to several hunters, October (16 percent) is a preferred month for hunting caribou, because the caribou have by then accumulated a thick layer of fat for the winter. September (8 percent) is normally consumed with whaling activity, and meat from caribou hunted in August is provided to whaling crews. March (6 percent) represents the beginning of spring, with longer days and warmer weather encouraging hunters to go out on the land again and harvest caribou.

Summer is the major caribou harvest season by proportion of individual caribou taken, and hunting is undertaken by boat. Large numbers of caribou migrate to the coast and shallow waters of Harrison Bay, and to the Colville River Delta in July to get away from mosquitoes. This behavior allows subsistence hunters to harvest numbers of caribou adequate for subsistence in a relatively short amount of time. Because of the risk of spoilage, the harvested caribou must be processed and stored quickly, whether in ice cellars at camps or brought back to Nuiqsut and put in freezers. Outboard boats provide rapid transportation for the hunters and their harvest. August is a time of increased bot and warble fly activity, and the caribou disperse into smaller groups and go south, as coastal winds provide little relief from flies (SRB&A 2003).

Winter harvests take place after the rivers and lakes have frozen over and snow covers the tundra, allowing for a greater overland hunting range using snowmobiles. Interviewed hunters have ranged from the vicinity of Admiralty Inlet and Teshekpuk Lake in the west, to the Franklin Bluffs area east of the Dalton Highway, south to Anaktuvuk Pass, and along the northern foothills of the Brooks Range (Figure 3.4.3.2-4). Caribou are hunted as needed while hunters pursue wolves, wolverines, and foxes southeast of Teshekpuk Lake, in the Brooks Range foothills, the

Kuparuk Hills, and east of the Colville River. Subsistence caribou hunting independent of the furbearer harvest continues all winter throughout the Fish and Judy creeks area, along the Nigliq Channel, and south along the Colville and Itkillik rivers. During the coldest months, many hunters stay closer to Nuiqsut, venturing farther out as spring approaches (SRB&A 2003).

March represents the beginning of spring as the days grow longer and temperatures increase. Preparations for Nalukataq begin in March as senior whaling crew members hunt caribou and other resources. In April, the snow is often “too rotten” to travel over the tundra, limiting overland travel by snowmobile. Caribou are harvested near the village and along frozen waterways at this time, but as spring approaches the caribou are often thin and not in the best condition (SRB&A 2003).

Figure 3.4.3.2-6 shows harvest locations by season for caribou harvested at known locations in 1993, 1994 through 1995, 2000, and 2001. The greatest proportion of caribou, both summer and winter, were harvested at Fish and Judy creeks, in the Nuiqsut area, and in the Colville River Delta including Nigliq and the Nigliq Channel. The Nuiqsut area itself is the second largest winter harvest location and fourth largest summer harvest location.

There are several reasons for this, including expedience, accessibility in both summer (boat) and winter (snowmobile), coordination with work obligations, efforts to avoid spoiling the meat, lack of transportation or gas money, general availability of caribou in both seasons, and a desire to combine caribou harvesting with fishing, waterfowl hunting, and berry picking. More distant harvest locations for caribou are associated with camps, cabins, and allotments (Figure 3.4.3.2-2) where caribou can be hunted, processed, and stored while other subsistence tasks are undertaken, such as fishing and berry picking. During the summer and winter it is common practice for experienced Nuiqsut hunters to take younger, less experienced hunters to Fish or Judy creeks, Nigliq, the Colville River Delta, or Itkillikpaat to fish and harvest caribou. They stay at a cabin or campsite of their own, or at one that belongs to a friend or relative. These activities provide multiple traditional foods for the community through sharing and distribution upon the hunters’ return. Furthermore, they serve to transfer to younger hunters a multi-generation knowledge of and identification with specific harvest, processing and storage methods, and traditional harvest locations. In summary, these subsistence activities in these specific locations reinforce the cultural identity of the community and residents’ identification with their unique history. As shown on Figure 3.4.3.2-7, 41 percent of the caribou harvested during the 1993, 1994 through 1995, 2000, and 2001 study years were harvested in the Colville River Delta and 25 percent harvested in the Fish and Judy creeks area. Thus, 66 percent of the caribou harvested in this time period were harvested in these two areas.

FISH USE AREAS

Nuiqsut resource users have a long history of subsistence fishing in the Colville River and its tributaries from the Colville River Delta to the confluence with the Ninuluk Creek, the Nigliq Channel and nearby Fish and Judy creeks, and innumerable lakes in the region. Nuiqsut fishermen also use coastal areas east to the Kuparuk River and fish around several barrier islands, including Thetis and Cross islands (Figure 3.4.3.2-8). Many families set nets near Nuiqsut in the Nigliq Channel when time, transportation needs, or funds do not permit longer trips from town, particularly during the school and work year. Cooperative arrangements are made between resource users wherein resources (such as time, equipment, gas, and labor) are pooled in exchange for shares of the harvest. Resource users often fish in conjunction with other subsistence activities, such as caribou and moose hunting and berry picking, especially in harvest areas with camps and cabins. Certain species of fish are only seasonally available, and must be harvested when present in the area. Nuiqsut fishers freeze or dry these fish for later use and barter. Other fish species are available year-round and provide a welcome change in diet and fresh food during the winter and spring (SRB&A 2003).

Fish comprise approximately one-third of the subsistence harvest of Nuiqsut residents (Table 3.4.3-2). This percentage varies with fish availability and the availability of other resources, such as caribou and bowhead whales (Brower and Hepa 1998). Subsistence fishing in Nuiqsut has been the subject of scientific research since 1985, when studies were undertaken in response to harvest failures that resource users associated with the construction of nearshore infrastructure for oil development (Moulton 2000). In addition, the NSB Department of Wildlife

Management has also collected information on Nuiqsut subsistence fish harvests for the years 1994 through 1995, 2000, and 2001 (Brower and Hepa 1998; NSB 2003 [unpublished]).

There are significant differences in sampling in the last 3 years of the 17-year Moulton studies (Moulton 2000, 2002), and in methodology and sampling between the Moulton studies and the NSB studies. From 1985 to 1998, Moulton collected data from five net sites (Upper Nigliq, Nanuq, Nigliq Delta, Outer Delta, and the Main River) in the Colville River Delta on subsistence harvests of Arctic cisco, least cisco, broad whitefish), and humpback whitefish).

Moulton did not conduct the studies in 1999. The Moulton studies resumed in 2000, but in that and subsequent years only the subsistence harvest on the Nigliq Channel sites (for example, Upper Nigliq, Nanuq, and Nigliq Delta) were reported.

The data collected by the NSB is broader in scope, geographically and by species, than the Moulton data. Harvest information collected by the NSB includes data for char (iqalukpik), burbot (tittaaliq), pike (siulik), salmon, and grayling (sulukpaugaq), in addition to the cisco and whitefish species addressed by Moulton. The NSB harvest locations reflect those reported in the 2003 Nuiqsut SRB&A interviews, with summer and winter fishing taking place in the Nigliq Channel, Colville River and Delta, and in Fish and Judy creeks, as well as other locations in specific seasons using both nets and angling gear (Brower and Hepa 1998; SRB&A 2003; Figure 3.4.3.2-8). The relative value of different species to local resource users reported in interviews ranged from valued staples (for example, cisco and whitefish) to the highly prized (such as burbot). Burbot, which are caught by jigging through holes in the ice in the Nigliq Channel and other Colville River Delta channels, the Colville River, and Fish and Judy creeks, are highly prized for their large livers and high fat content in the winter but are harvested in numbers that do not compare with the volume of some other species (SRB&A 2003).

The Moulton data show the highly variable nature of the subsistence fish harvest in the Colville River Delta and Nigliq areas. Arctic cisco harvests range from approximately 6,100 in 1988 to nearly 47,000 in 1993, approximately 7.5 times as many as the low, as shown on Figure 3.4.3.2-9. Fishing effort in net days ranged by area from 19 to 1,407 net days (Figure 3.4.3.2-10), although there is no clear correspondence between the harvest and harvest effort, because low efforts brought more fish, as in 1993, while high efforts as in 2002 resulted in few fish harvested even considering the reduced number of sites sampled.

The NSB subsistence harvest data for 1994 through 1995, 2000, and 2001 show the greatest proportion of fish are harvested in October (54 percent), November (13 percent), July (11 percent), December (4 percent) and September (4 percent) (Figure 3.4.3.2-11). Undated fish harvests (9 percent) are the fourth largest group. The large number of fish harvested reflects the importance of the resource in general, but in particular demonstrates the numerical dominance of Arctic cisco to the fall and winter harvest, as shown on Figure 3.4.3.2-12. The variability in Arctic cisco harvest as shown on Figure 3.4.3.2-9 demonstrates the importance of having alternative species and harvest strategies available should poor fish harvests coincide with reduced terrestrial or marine mammal harvests.

Key fishing areas measured by total harvest for all species, shown on Figure 3.4.3.2-13, include areas around Nuiqsut and throughout the Colville River Delta, including Nigliq and the Nigliq Channel. Arctic cisco harvests were removed from the analysis because of their large proportion in order to examine fish harvested in smaller proportions. Figure 3.4.3.2-14 shows that the Colville River Delta remains an important Nuiqsut fish harvest location, even excluding Arctic cisco. In addition, Nanuq Lake, Fish Creek, and upriver locations are also important for harvesting of fish other than Arctic cisco.

Resource users set nets in the Nigliq Channel for broad whitefish in June and July, as the fishery is accessible on foot, by boat, truck, or all-terrain vehicle. Several interviewed resource users stated that “everybody in town goes down there if they can.” In August and September, fishers set nets and angle in the Nigliq Channel, Nanuq Lake, Fish Creek, and the Colville River Delta, or travel by boat up the Colville River up to and beyond Umiat for grayling, chum salmon, silver salmon, and arctic char. Some fish in the nearshore waters inside the barrier islands, and this is often done by Nuiqsut bowhead whaling crews to support them while they are at Cross Island (Figure 3.4.3.2-8). In the fall and early winter, grayling gather at river mouths, and nets are set under the ice for other fish migrating out of the rivers for the winter, including whitefish and cisco. Jigging through the ice continues until the coldest months of winter for burbot, grayling, and rainbow trout (SRB&A 2003).

Fishing is an important family activity and is an opportunity for several generations to gather at camps for cooperative fishing and other resource harvests. Elders from the area know the most productive fishing spots, which species are available at which locations, and the best times to fish for them. Angling and jigging is done by children, as well as elders in all seasons, and species harvested by these methods are highly valued. For example, one Nuiqsut resident spoke of the high local value placed on burbot livers when he said, “We all eat that! We get them for the liver; it is rich and the meat is rich.” Net fishing along the Nigliq Channel and at cabins and camps on Fish Creek in the summer are highly valued family activities, as Nuiqsut families cooperate for weeks at camp, catching and drying whitefish for later consumption and distribution. Family members with year-round wage jobs work in town while other family members of all ages work at the camps, with wage workers returning in the evenings or weekends to bring supplies, visit, and participate in subsistence activities (SRB&A 2003).

WATERFOWL USE AREAS

Waterfowl harvested by the Inupiat of Nuiqsut occupy two habitats in the greater area. Ducks, geese, and brant nest and molt in the wet tundra to the north. Eiders nest on the sandy areas of the Colville River Delta and the barrier islands, and molt after their arrival. Both groups of waterfowl raise their young in the area until fall, when they migrate south. Nuiqsut hunters harvest waterfowl in May and June during the migration using snowmobiles and boats. Geese hunting areas include the Fish and Judy creeks area, the Colville River Delta, the area around Nuiqsut extending to the Fish and Judy creeks area, along the Colville River up to Sentinel Hill, the area around Ocean Point, and along the Itkillik River (Figure 3.4.3.2-3).

The hunters harvest the migrating birds from snow blinds built to the south, near Sentinel Hill and Ocean Point, or at Fish Creek. Once the river breaks up, hunters look for birds by boat, and start to look for eiders in the delta and in Harrison Bay at the ice edge as summer approaches. Hunters end the waterfowl harvest when the birds are on their nests (SRB&A 2003).

In earlier times, Inupiat resource users harvested flightless molted birds by cooperatively “herding” them into creeks, then dividing the harvest between the work group members. One resident remembered doing this as recently as the late 1940s at Oliktok Point. Nuiqsut people in the past gathered and stored eggs from waterfowl nests on the tundra. Twenty-one Nuiqsut harvesters interviewed in 2003 stated that they no longer gather eggs, and that they do not harvest certain species of waterfowl for various reasons. Some residents indicated that they do not eat certain varieties of ducks (e.g. old squaws, pintails), while many chose to avoid harvesting black brant and spectacled eiders because they are endangered. Nearly all interviewed resource users harvested geese in May, and most harvested some eiders (SRB&A 2003).

The NSB collected waterfowl harvest data for 1994 through 1995, 2000, and 2001 (Brower and Hepa 1998, NSB 2003). Figure 3.4.3.2-15 shows that 79 percent of geese, including white fronted and Canada, were harvested in the Fish and Judy creeks area (63 percent) and the Colville River Delta (16 percent). Of the remaining 21 percent, most were harvested up the Colville River from Ocean Point to Umirak. A more specific view of goose harvest locations is shown on Figure 3.4.3.2-16, with 47 percent of harvested geese coming from Fish Creek alone, and many of the rest harvested in the Colville River Delta and Nuiqsut areas.

Figures 3.4.3.2-17, 3.4.3.2-18, and 3.4.3.2-19 show harvest locations that reflect the more specialized habitat of eiders. More than half (53 percent) were harvested in the ocean, with Thetis Island, Atigaru Point, and Point Barrow as other maritime harvest locations. The Colville River Delta and its channels were the major freshwater harvest areas for eiders, accounting for 28 percent of the eider harvest. The Kogru-Kalikpik River area comprised 2 percent of the eider harvest.

Waterfowl are an important subsistence food and are the first fresh meat in the spring. Waterfowl are an important food for Nalukataq celebrations held by whaling captains in the early summer, and whaling crew members spend considerable effort in harvesting them. Waterfowl are harvested by hunters walking down the Nigliq Channel after work or school without investing in fuel and equipment. Waterfowl hunting trips also are sometimes the last overland trips made to cabins and camps on Fish and Judy creeks and along the Nigliq Channel before conditions make it impossible to use snowmobiles for the season. The first boat trips of the year are taken to harvest seals and eiders (SRB&A 2003).

FURBEARER USE AREAS

During the 2003 interviews, Nuiqsut hunters described three species of terrestrial furbearers as being especially important: wolf, wolverine, and fox. Once there is adequate snow in the winter for snowmobile travel, generally by November, hunters begin the pursuit of wolf and wolverine in earnest. The harvest area for furbearers extends from the eastern edge of the Colville River Delta along the coast almost to Admiralty Bay, south along the Ikpikpuk River to the Colville River and eastward to the Toolik River, north and acrossthe Dalton Highway to Franklin Bluffs, and west and north back to the Colville River Delta. The southern extent, in some cases, extended off of the map used for the interviews (Figure 3.4.3.2-8).

A typical furbearer hunt involves one to three hunters who travel over this vast area looking for wolf and wolverine tracks and signs. When the hunters spot tracks, they follow them until the animal can be harvested. Foxes are sometimes trapped, but only a few of the hunters interviewed still set traps. Several hunters considered fox furs harvested inland to be of better quality than those on the coast, particularly those of arctic fox, which feed on seal scraps left by polar bears and get greasy, thus staining their fur (SRB&A 2003).

Wolverine harvest locations reported for 1994 through 1995, 2000, and 2001 are divided evenly between the Colville River Delta and Fish and Judy creeks (48 percent) and other areas (52 percent), as shown on Figure 3.4.3.2-20. Similarly, 55 percent of wolves harvested during these years were harvested in the Fish and Judy creeks area, with the balance harvested elsewhere (Figure 3.4.3.2-21). One hunter, explaining where wolves and wolverines could be found, said, “Wolf, wolverine, and caribou go to the lowest levels, which have the best hiding spots. These are rivers, bluff bases, creeks, frozen ground, and low level places that allow them to hide.” (SRB&A 2003)

The relatively small numbers of wolves and wolverines harvested belies their importance to the community in several ways. The pursuit of furbearers is a friendly, competitive pursuit both within the village and between villages, primarily for males, and has important functions in teaching younger hunters the landmarks and resources of a very large area. Occasionally furbearer hunters will encounter people from other villages on the tundra also engaged in furbearer hunting, fostering connections between villages in a mostly male social context. Wolf and wolverine fur continues to be an important and highly valued component in Inupiat clothing. There is an economic interest in fur hunting despite the relatively poor commercial market for fur, with one fur hunter stating that he received $450 for a good wolverine pelt, and $600 for a wolf pelt. This allowed him to pay for enough gas for a trip to Barrow (SRB&A 2003).

MOOSE USE AREAS

As depicted on Figure 3.4.3.2-22, moose (are hunted from the Colville River Delta area upstream to Ninuluk Creek, up the drainages of the Itkillik River and Fish and Judy creeks, and up some side streams off the Colville River. One hunter mentioned going almost to the Killik River confluence looking for moose, while several others reported Fish and Judy creeks, the Chandler and Anaktuvuk river confluences, several side streams and channels of the Colville River, and the Itkillik River area as prime moose hunting areas (SRB&A 2003). Although few moose are harvested, they are a valued component of the subsistence harvest in Nuiqsut, and hunters spend considerable effort in their pursuit. From 1994 through 1995, five moose harvests were reported (Brower and Hepa 1998). Moose offer a significant amount of meat per animal harvested because of their relatively large size compared to other terrestrial mammal subsistence resources.

August is the only month for Nuiqsut residents to harvest moose according to subsistence regulations. Many hunters plan their work schedules around this harvest period in order to participate. Moose meat is often supplied to whaling crews who usually head for Cross Island in early September. Trips including extended families and friends, as many as six boats full, travel at this time to Fish and Judy creeks, up the Colville River to the general area of Umiat, or up the Itkillik River. Camps are set up and cabins and caches cleaned. As with other subsistence activities, these trips provide opportunities for other harvest activities including caribou hunting, fishing, and berry picking. Evenings at camp are a time for visiting, telling stories, and teaching younger people about subsistence practices (SRB&A 2003).

SEAL USE AREAS

Ringed, spotted, and bearded seals are important subsistence resources for Nuiqsut hunters. As depicted on Figure 3.4.3.2-22, seals are harvested along the coast and offshore from Cape Halkett in the west to Foggy Island Bay in the east. In the summer, Nuiqsut hunters harvest ringed and spotted seals in the Colville River as far south as Ocean Point. Hunters usually shoot seals in the water and on the ice edge in the spring (SRB&A 2003).

In April and May, hunters ride out to Harrison Bay on snowmobiles and look for breathing holes, cracks in the ice, and open water where seals could surface to breath. By the second week in June, open waters on the Colville River and much of Harrison Bay allow hunters to take boats out on a route locally called “around the world,” following the Nigliq Channel to Harrison Bay, west to Atigaru Point, then along the ice edge out as far as 28 miles, then to Thetis Island, east to Oliktok Point, then back south through the main channel of the Colville River. Thetis Island is used as a shelter should the weather turn bad, as it is crescent shaped and provides protection from wind in three directions. This route is also used to harvest eiders and occasionally walrus (SRB&A 2003).

Seals are a culturally important subsistence species for food, skin, and barter. In historic times, seal oil lamps provided heat and light for Inupiat dwellings and was used as a condiment for dried foods. Seal is still locally consumed and traded to Anaktuvuk Pass residents for dried caribou and other products. Seal skins are used for handicrafts and other articles, bartered, or sold (SRB&A 2003).

BOWHEAD WHALE USE AREA

The recent Nuiqsut subsistence bowhead whale hunting area is depicted on Figure 3.4.3.2-17. The general Nuiqsut harvest area for bowhead whales is located off the coast between the Kuparuk and Canning rivers. Nuiqsut has been a bowhead whaling community since its reestablishment in 1973. Whalers currently travel to Cross Island to conduct fall bowhead whaling. They have also used Narwhal Island as a base, and still have structures there. Cross Island has cabins and equipment for hauling and butchering the whales. Nuiqsut hunters typically travel out either the Nigliq or the main Colville channel of the Colville River Delta depending on water levels, and travel along the coast inside or just outside the barrier islands. Often they will stop at West Dock for coffee before heading due north for Cross Island. Whalers opportunistically harvest seals, caribou, and polar bears en route. After setting up camp, work groups will start fishing and hunting other species to support the whalers.

BERRIES USE AREA

Berries and plants, as shown on Figure 3.4.3.2-17, are a widely dispersed resource available for a very short time. Berries of numerous varieties are harvested in the Fish and Judy creeks area, and along the Colville, Chandler, Anaktuvuk, and Itkillik rivers. Plants such as masu (Eskimo potato), medicinal plants, and greens are harvested at the same time, usually when families are out at camp hunting and fishing in the late summer. Berry picking is still considered a job primarily for women and children, but many men mentioned picking berries as well. Berry varieties include salmonberries and blueberries. Berries are primarily harvested in August, when many families are moose hunting near the creeks and rivers in the area, and often they will fill buckets or large freezer bags of berries. These are taken home and stored in ice cellars or freezers for later use in akutuq (Eskimo ice cream) made from whipped seal or other fat, sugar, plants, and berries.

SUBSISTENCE USER AVOIDANCE OF DEVELOPED AREAS

Following the reestablishment of Nuiqsut in the Colville River Delta in 1973, community residents began to refamiliarize themselves with the subsistence resources of the area based on the knowledge of elders that had remained in the area or continued to use the area while living in other communities. Their subsistence harvest and use areas for this period are documented in *Nuiqsut Paisaŋich* in a series of maps (Brown 1979), by the NSB as part of its program of traditional land use documents (Hoffman, Spearman, and Libby 1988), and by Pedersen (1979 and In Prep). At that time, oil development was some distance from the community, but its impacts were felt by residents who had ties to the developed area and by residents who wished to use subsistence areas on the east side of the developed area (Brown 1979; Appendix A). These issues and concerns were documented in the early 1980s by researchers working under contract to the MMS for the Social and Economic Studies Program (Institute for Social and Economic Research [ISER] 1983). Chapter 6 of the report documented that the Iñupiat subsistence users perceived that there was a high potential for conflicts between industrial and Inupiat land uses and subsistence access. Figures 7 and 8 of the report showed subsistence use areas overlain on industrial areas closed to subsistence and the vast expanse of land potentially offered for lease. Chapter 7, *Perceived Threats of Oil Development,* outlines the conflicts and concerns between Inupiat subsistence uses and industry (ISER 1983:181-250). No other community in Alaska is as close as Nuiqsut to intensive oil exploration and development, and this proximity is reflected in residents' increased concerns about reduced subsistence access through increased regulations, competition with outsiders, and the imposition of physically obstructive facilities in traditional use areas (ISER 1983:223-225).

Through the 1980s, the industrial developed area expanded overland west from Prudhoe Bay, and the possibility of nearshore and offshore development near Nuiqsut was impending (IAI 1990a). By 1985, development encompassed subsistence and traditional use areas from Oliktok Point south along the Kuparuk River (Pedersen, Wolfe, Scott, and Caulfield 2000: Figure 4). The harvest of marine resources at specific locations was complicated or prevented by onshore development at traditional camps (e.g., Oliktok Point, Niakuk) and by offshore activity (e.g., drilling, seismic testing, and sealift) (Pedersen et al. 2000).

By 1990, Galginaitis wrote in MMS SESP Special Report 8 that, "Perhaps the most obvious effect of oil development in the Nuiqsut area has been that it has effectively removed certain areas from the Nuiqsut subsistence land uses area." (IAI 1990a:1-43) Subsistence users' reasons for avoiding or not avoiding areas in response to oil development in the late 1980s were similar to those noted in the 1983 ISER study and included regulatory contraints (real or perceived), a perception of restriction, lack of cultural privacy, notice or belief that a resource is contaminated, and physical obstacles and barriers such as low pipelines and steep gravel road sideslopes (IAI 1990a: 1-43-44, ISER 1983).

As shown on Figure 3.4.3.2-2, Nuiqsut subsistence use areas have retreated from the east as development moved westward from Prudhoe Bay to Oliktok Point, particularly in the area of the Kuparuk field. Onshore development displaced subsistence uses east of the Colville River for the majority of Nuiqsut users, and the few who continued to use the area did so primarily for political purposes and did not take many caribou there (IAI 1990a: 1-44). By 1990, the concern in the community of Nuiqsut was that development would continue to encroach on their shrinking subsistence and traditional use areas on the Itkillik and Colville rivers and the Colville River Delta (IAI 1990a: 1-46). At that time, some hunters noted that further development in these subsistence use areas would impose a severe hardship on the community of Nuiqsut (IAI 1990a: 1-46).

In 1993, onshore subsistence harvests and uses east of the Colville River and north of Nuiqsut declined to near zero, and development activity was encroaching on valued traditional use areas (Pedersen et al. 2000). Whaling at Cross Island, the use of onshore camps, and storage of the bowhead harvest at Oliktok Point became deeply entwined with oil company personnel and oversight, as companies sought to minimize the time spent by Iñupiat hunters in the developed areas and to avoid attracting polar bears to Oliktok Point by shipping whale meat and *maktaq* by air to Nuiqsut (Pedersen et al. 2000). This assistance has some advantages in time and convenience for subsistence users; however, this practice reduced the autonomy of the hunters and subjected them to scrutiny and regulation throughout the whaling process, which eliminated the perception of cultural privacy (Pedersen et al. 2000).

The 1993 Nuiqsut caribou harvests within the developed area were at or near zero, four percent were within five miles of developed areas, 17 percent were harvested from six to 15 miles, and 79 percent were harvested more than 16 miles from development (Pedersen et al. 2000:18). The 1994 caribou harvest data were similar (Pedersen et al. 2000) in terms of the percent of caribou harvested in relation to harvest proximity to development. Key informants noted in a 1998 Nuiqsut group session that they no longer used the developed area northeast of Nuiqsut as intensively as they had in the past due to difficulties of access, lack of privacy, loss of cultural landmarks, uncertainty regarding regulations, and oilfield security enforcement (Pedersen et al. 2000:18).

Harvest locations and amounts for caribou for the study years reported in Pedersen et al. 2000 (i.e., 1993 and 1994) are consistent with the published and unpublished harvest location data from the North Slope Borough Division of Wildlife Management for 1994-95, 2000 and 2001 (Brower and Hepa 1998; North Slope Borough Department of Wildlife Management 2003). Thus, the NSB data and Pedersen et al. (2000) findings support that Iñupiat subsistence users harvest most of their caribou in locations that are distant from developed areas east of the Colville River. This shift applies to most subsistence resources, these changes are ongoing in response to industrial encroachment, and are similar to those predicted in 1990 (Pedersen et al. 2000, IAI 1990a). The main reasons for this avoidance of previously used areas east of the Colville River cited by Pedersen et al. include "difficulties of access, lack of privacy when hunting, loss of cultural landmarks, uncertainty regarding regulations in the area, and oilfield security enforcement" (Pedersen et al. 2000:18).

Pedersen and Taalak (2001) conducted a survey of Nuiqsut households for the June 1999 through May 2000 time period. Caribou were the most widely used terrestrial big game resource in Nuiqsut, with an average of four caribou per household when averaged for all community households. According to an open file draft report by Pedersen and Taalak (2001), 75 percent of the 371 caribou harvested by Nuiqsut hunters from June 1999 through May 2002 with known harvest locations were harvested west of Nuiqsut, 11 percent in the immediate vicinity of the community and only 14 percent to the east. Seventy-eight percent of all known caribou harvests occurred away (6 to greater than 16 miles) from oil production facilities in 1999 and 2000. Twenty-two percent were reported harvested in peripheral areas (0 to 5 miles) to development and there were no reports of harvests during this time period inside the industrial developed area. In general, these findings are consistent with the earlier conclusions for the 1993 and 1994 caribou harvests (Pedersen et al. 2000). However, the 1999 and 2000 caribou harvest distances greater than 16 miles from oil development dropped to 51 percent compared to 79 percent in 1993 and 77 percent in 1994. This change is the result of oil development (Alpine Field) moving west into the Colville River Delta, an area of focused Nuiqust caribou harvests, especially June through September. Development in this area is too recent and there are insufficient data available to conclude whether or not harvesters will increase their distance from development in response to this relatively new facility. Furthermore, in 1999 and 2000, the Alpine Field footprint was relatively small compared to larger development east of the Colville River, and CPAI has made efforts to work with Nuiqsut to accommodate hunters. Systematic, time series monitoring of subsistence harvests and locations to document any changes to subsistence harvest patterns is being undertaken in Nuiqsut, Barrow, and Atqasuk by the ADF&G and the ICAS (Pedersen 2004:personal communication). Based on Pederson et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 78 percent of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River and 51 percent of the 1999 and 2000 harvests occurring greater than 16 miles, and 27 percent occurring 6 to 15 miles from Alpine Field development.

Further development anticipated in Pedersen et al. (2000) has come to pass with the development of the Alpine Field Meltwater, Tarn, Fiord, and other oilfields in the vicinity of Nuiqsut. This ongoing development has contributed to a feeling of being "boxed in" for Nuiqsut subsistence users (Pedersen et al. 2000:4, 19). The Committee on the Environmental Effects of Oil and Gas Activities on Alaska's North Slope recently concluded in a National Research Council report that,

> "On-land subsistence activities have been affected by the reduction in the harvest area in and around the oilfields. The reductions are greatest in the Prudhoe Bay field, which has been closed to hunting, and in the Kuparuk field, where the high density of roads, drill pads, and pipelines inhibits travel by snow machine. The reduction in area used for subsistence is most significant for Nuiqsut, the village closest to the oilfield complex. Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread." (National Research Council 2003:156)

BARROW SUBSISTENCE ACTIVITIES

The Inupiat name for the Barrow area is Utqiagviq, meaning “the place where we hunt snowy owls.” Barrow is situated on a point of land where the sea ice is prone to cracking. The main subsistence focus, however, has been marine mammal hunting, in particular, whaling. Barrow is one of 10 Alaska Eskimo bowhead whaling communities. Bowhead whale hunting is the key activity in the organization of social relations in the community and represents one of the greatest concentrations of effort, time, money, group symbolism, and significance (SRB&A and ISER 1993). Other harvested resources, such as caribou, waterfowl, and several varieties of fish, are vital for subsistence and available near Barrow but have less influence on the organization of social relations. The reliance on subsistence activities remains a key component of the Barrow economy and the local Inupiat culture.

CONTEMPORARY SEASONAL ROUND

Barrow’s seasonal round is related to the timing of subsistence resources. Preparation for bowhead whaling occurs year-round. Barrow hunters harvest caribou in April; however, because of pre-calving and calving, hunters usually refrain from taking caribou until late June. The harvest of eiders and geese begins in early to mid-May, weather and ice conditions permitting. Spring bowhead hunting occurs during April and May, with May generally being the most successful month (SRB&A and ISER 1993). In the past, as they hunted whales, crew members also opportunistically hunted a number of other marine mammals, such as seals and polar bears. Beginning with the whaling season of 1978, bowhead whale quotas instituted by the International Whaling Commission altered traditional spring whaling activities by reducing opportunity for harvesting bowheads and limiting the pursuit of other marine mammals so as not to jeopardize the bowhead hunt.

Once the spring whaling season is over, usually late May or early June, subsistence activities diversify. Some hunters turn their attention to hunting seals, walrus, and polar bears, while others go inland to hunt for waterfowl. In June, Inupiat hunters continue to hunt geese and opportunistically harvest caribou, ptarmigan, and eiders. Barrow residents harvest caribou in July and August when they are available to people hunting from boats. In addition, caribou are in peak condition in August, and Barrow hunters prefer to harvest them at that time (Fuller and George 1999). Barrow hunters also harvest marine mammals, eiders, and fish, and caribou in August, depending on the weather and ice conditions. Bearded seals are harvested principally for their blubber, which is rendered into oil, and for their skins, which are used for boat coverings. Barrow hunters harvest ringed seals primarily for their meat. Walrus are harvested in July and August when they drift north with the floe ice and if the pack ice moves close enough to Barrow. Freshwater fishing occurs from break-up (June) through November (Fuller and George 1999). Residents fish for arctic cod year-round, but broad whitefish, the most heavily harvested species, are harvested from June to October (Fuller and George 1999). Fish harvested in August include whitefish, grayling, salmon, and capelin. When the weather turns warm, Barrow hunters typically harvest caribou by boat along the coastal areas as the caribou move to the coast to escape the heat and insects. Residents of Barrow harvest eiders during the “fall migration” in July at Pigniq or “Duck Camp.” Families may go up the Colville River to harvest moose and berries during moose hunting season in August and early September (Fuller and George 1999).

If ice conditions are favorable, fall bowhead whaling can occur as early as mid-August and continue into October. More recently, Barrow whalers have agreed to start the fall whaling season in early October in order to harvest the smaller preferred whales. Residents of Barrow who have remained inland hunt caribou if the animals are accessible; otherwise, they concentrate on fishing for broad whitefish. The subsistence fish harvest generally peaks in October (under-ice fishery), when whitefish and grayling are concentrated at overwintering areas (Fuller and George 1999). Barrow residents also harvest ground (or parka) squirrels and ptarmigan, and, if weather and ice conditions permit and the animals appear close to town, seals and caribou are harvested during November and December (SRB&A and ISER 1993). During the winter months, residents of Barrow harvest furbearers. Table 3.4.3-4 summarizes Barrow’s annual cycle of subsistence activities.

TABLE 3.4.3-4 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – BARROW

	Winter					Spring		Summer			Fall	
	Nov	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Fish	▒	□	□	□	□	□	□	▒	■	■	■	■
Birds	□	□	□	□	□	□	▒	■	■	■	▒	▒
Berries	□	□	□	□	□	□	□	□	□	■	■	□
Furbearers	▒	▒	▒	■	■	□	□	□	□	□	□	□
Caribou	▒	▒	▒	▒	▒	▒	□	▒	■	■	■	■
Polar Bear	□	□	▒	▒	▒	□	■	▒	□	□	□	□
Seals	■	▒	■	□	□	▒	■	■	■	□	□	□
Walrus	□	□	□	□	□	□	□	▒	■	▒	□	□
Bowhead	□	□	□	□	□	■	■	▒	□	■	■	■

Sources: SRB&A & ISER 1993; SRB&A 2003.
Notes:

□	No to Very Low Levels of Subsistence Activity
▒	Low to Medium Levels of Subsistence Activity
■	High Levels of Subsistence Activity

SUBSISTENCE HARVEST ESTIMATES

SRB&A collected Barrow subsistence harvest data for 1987, 1988, and 1989 (SRB&A and ISER 1993). Barrow's total annual subsistence harvests ranged from 621,067 pounds in 1987 to 614,669 pounds in 1988, and 872,092 in 1989 (Table 3.4.3-5). The 1989 harvest of 289 pounds per capita of wild resources represents nearly 1 pound per day per person in the community. Barrow residents rely heavily on large land and marine mammals and fish (Table 3.4.3-5). Marine mammals comprised approximately 55 percent of the total for the three study years, and land mammals contributed 30 percent of the total.

Bowhead whales, caribou, walrus, and whitefish accounted for approximately 85 percent of Barrow's annual subsistence harvest in terms of edible pounds in 1989 (Table 3.4.3-6). In 1992, the total harvest of marine mammals (bowhead whales, walrus, and ringed and bearded seals) accounted for approximately 72.5 percent of the total village harvest of all species, and bowhead whales provided the single greatest contribution of food to the community (Tables 3.4.3-5 and 3.4.3-6) (Fuller and George 1999). The success of bowhead whaling in 1992 resulted in a relative decrease in the harvest of other resources such as fish. Land mammals (caribou, moose, and Dall sheep) contributed approximately 18.5 percent of the total harvest in Barrow in 1992, and caribou was the principal terrestrial resource. Nearly half (45 percent) of Barrow households participated in caribou hunting in 1992 (Fuller and George 1999). In general, caribou is one of the most consistently eaten subsistence resources in Barrow (Fuller and George 1999). In 1992, fish constituted approximately 7 percent of the total harvest in Barrow, with broad whitefish being the most important fish resource. Birds (eiders and geese) contributed less than 2 percent of the total harvest by weight; however, participation in bird hunting was high (Fuller and George 1999).

TABLE 3.4.3.5 BARROW SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES, 1987-1992

	Percentage of Households					Estimated Harvest				
Resource	**Use**	**Try to Harvest**	**Harvest**	**Receive**	**Give**	**Number**	**Total Pounds**	**Mean HH Pounds**	**Per Capita Lbs.**	**% Total Harvest**
1987										
All Resources			58				621,067	663	206	100
Fish			33			45,563	68,452	73	23	11
Salmon			3			196	1,190	1	0	<1
Non-Salmon						45,367	67,262	72	22	11
Land Mammals			30			1,893	213,835	228	71	34
Large Land						1,660	213,777	228	71	34
Small Land						233	58	0	0	<1
Marine Mammals			41				316,229	337	105	51
Birds and Eggs			36			10,579	22,335	24	7	4
Vegetation			3				216	0	0	<1
1988										
All Resources			50				614,669	656	204	100
Fish			18			38,085	51,062	54	17	8
Salmon			1			80	490	1	0	<1
Non-Salmon			14			38,005	50,571	54	17	8
Land Mammals			27			1,751	207,005	221	69	34
Large Land			27			1,599	207,005	221	69	34
Small Land						152	0	0	0	<1
Marine Mammals			39			654	334,069	357	111	54
Birds and Eggs			34			9,183	22,364	24	7	4
Vegetation			2				169	0	0	0
1989										
All Resources			61				872,092	931	289	100
Fish			29			68,287	118,471	126	39	14
Salmon			10			2,088	12,244	13	4	1
Non-Salmon			13			66,199	106,226	113	35	12
Land Mammals			43			1,774	214,683	229	71	25
Large Land			39			1,705	214,676	229	71	25
Small Land			2			68	7	0	0	<1
Marine Mammals			45				508,181	542	169	58
Birds and Eggs			41			12,869	29,446	31	10	3
Vegetation							1,312	1	0	<1
1992										
All Resources							1,363,736	1,190	349	100
Fish							96,003	84	25	7
Land Mammals							252,661	220	65	18.5
Marine Mammals							989348	863	253	72.5
Birds and Eggs							23,866	21	6	2
Invertebrates							694	1	0	<1
Vegetation							1,164	1	0	<1

Sources: SRB&A and ISER 1993 (for 1987-1989); Fuller and George 1999 (for 1992); SRB&A 2003.

TABLE 3.4.3-6 SELECTED BARROW SUBSISTENCE HARVESTS FOR 1987, 1988, 1989, AND 1992

Resource	Estimated Harvest				
	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1987					
Caribou	1,595	186,669	199	62	30
Bowhead	7	184,629	197	61	30
Seal	704	61,194	65	20	10
Walrus	84	64,663	69	21	10
Whitefish	27,367	51,253	55	17	8
Moose	52	25,786	28	9	4
Geese	2,873	12,740	14	4	2
Grayling	12,664	10,131	11	3	2
Polar Bear	12	5,744	6	2	1
Duck	5,252	7,878	8	3	1
1988					
Bowhead	11	233,313	249	77	38
Caribou	1,533	179,314	191	59	29
Seal	570	47,890	51	16	8
Walrus	61	47,215	50	16	8
Whitefish	20,630	39,766	42	13	6
Moose	53	26,367	28	9	4
Geese	3,334	14,672	16	5	2
Polar Bear	11	5,650	6	2	1
Duck	4,498	6,747	7	2	1
Grayling	8,684	6,947	7	2	1
1989					
Bowhead	10	377,647	403	125	43
Caribou	1,656	193,744	207	64	22
Whitefish	38,054	92,399	99	31	11
Walrus	101	77,987	83	26	9
Seal	440	33,077	35	11	4
Geese	3,944	16,289	17	5	2
Moose	40	20,014	21	7	2
Polar Bear	39	19,471	21	6	2
Duck	8,589	12,883	14	4	1
Grayling	8,393	6,714	7	2	1
1992					
Bowhead	22	729,952	637	187	54
Caribou	1,993	233,206	203	60	17
Walrus	206	159,236	139	41	12
Bearded Seal	81,471	463	71	21	6
Broad Whitefish	59,993	23,997	52	15	4

Source: SRB&A and ISER 1993 (for 1987-1989); Fuller and George 1999 (for 1992); SRB&A 2003

CONTEMPORARY SUBSISTENCE USE AREAS

The community of Barrow incorporates residents from throughout the NSB. Many residents tend to hunt in the areas where they were raised, which could include the subsistence harvest areas of other communities. Barrow residents may receive subsistence foods from areas outside of Barrow. Former residents and family members who now reside in Anchorage or Fairbanks may receive subsistence foods from Barrow. Pedersen (1979) documented Barrow subsistence use areas in the 1970s (Figure 3.4.3.2-23) and SRB&A and ISER (1993) conducted a 3-year subsistence harvest study in Barrow for the 1987 to 1989 harvest years (Figure 3.4.3.2-24). With a few exceptions that are generally associated with offshore and furbearer use, the harvest locations for the 1987 to 1989 study period are located within Pedersen's (1979) Barrow lifetime community land uses area, depicted on Figure 3.4.3.2-25. The documented Barrow subsistence use area represents a large geographic area, extending from beyond Wainwright in the west to the Kuparuk River in the east and south to the Avuna River. Inland use areas go beyond the Colville River to the foothills of the Brooks Range. The Barrow subsistence harvest data from both the 1970s and 1980s show Barrow residents using the Colville River Delta area for subsistence activities.

CONTEMPORARY SUBSISTENCE USE AREAS EAST OF THE COMMUNITY

In August 2003, SRB&A interviewed eight subsistence harvesters in Barrow. One purpose of these interviews was to learn whether and to what extent Barrow subsistence harvesters use the Kogru and Kalikpik rivers, Fish and Judy creeks, and Colville River Delta area for subsistence activities. These interviews focused on these three areas and did not represent a comprehensive discussion of Barrow subsistence use areas. SRB&A coordinated these interviews with the ICAS, which identified Barrow subsistence users for these interviews. ICAS chose subsistence hunters who either traveled far to the east of Barrow or who had been raised east of Barrow and returned to their "homeland" for subsistence activities.

As shown on Figure 3.4.3.2-25, the area currently used by the eight interviewed hunters generally coincided with the Barrow lifetime community land uses area east and southeast of Barrow with some exceptions: the interviewed hunters generally did not utilize the formerly used area east of the Itkillik River; they traveled farther south in the vicinity of the Anaktuvuk River; and they made expanded use of the area near the Titaluk and Kigalik rivers approximately 120 miles south of Barrow.

Generally, the interviewed Barrow hunters used the area east of Cape Halkett to pursue wolf, wolverine and caribou. The winter wolf, wolverine and caribou hunting area overlapped, as hunters looking for wolf and wolverine tended to travel over great distances and also harvested caribou on their travels. In summer, the caribou use area extended down the coast from Smith Bay to Cape Halkett, across the coastal areas of Harrison Bay, to the Colville River Delta and up the Colville River as far as Ocean Point. One Barrow interviewee indicated he had hunted moose in the Colville River from south of Umiat to approximately Ocean Point. The interviewed Barrow hunters indicated that they fished as far east as the lakes in the vicinity of Cape Halkett.

Several families now living in Barrow have elders who were born and raised along the coast between Smith Bay and the Colville River Delta. These families had moved to Barrow primarily because of the requirement that children attend school, with some moving to take jobs or access medical care. Most moved to Barrow in the late 1940s. Once they resided in Barrow, each family made special efforts to return to the Smith Bay to Cape Halkett area to continue traditional subsistence activities at traditional family harvest areas. Currently, the third generation of these families continues to use the area, often harvesting resources that are not as available in the Barrow area. These include furbearers (wolf, wolverine, fox, and arctic ground squirrels), caribou, and moose. Seals and fish are harvested closer to Barrow. A Barrow hunter described a recent summer caribou hunt:

> "When the Western Arctic Herd are further west from Barrow in Point Lay or Point Hope, that's too far to travel. We had to go east through the ocean to the Cape Halkett area and go into creeks looking for caribou. On nice warm days, you find caribou on the coast and in the water, in the end of July or the first part of August. We go for one week. My uncle has a cabin near Cape Halkett." (SRB&A 2003)

Furbearer hunts are unlike subsistence food resource hunts in that they are competitive but friendly. Furs are not shared in the same way as food resources, and the hunts are conducted over much larger areas. One hunter clearly stated this, saying, in good humor, "We fish closest to our own area, we do not try to step on each others toes with fish, but we have no respect [for territory] when it comes to wolf and wolverines!" Barrow residents from the same families noted for their connections with the Cape Halkett area use a vast area to the south and east of Teshekpuk

Lake for furbearer hunting and go into the Fish and Judy creeks, Ublutuoch River, Itkillik River, and Umiat areas while looking for wolves and wolverines (Figure 3.4.3.2-25). One hunter interviewed said, “I like to go to the south side of Teshekpuk Lake, Inigok, and Umiat before the snow is too soft, to get wolves and wolverines for clothing.” Another hunter, explaining his winter hunting by snowmobile, said,

> “From February through March, I travel to the east for furbearers. I go down to Price River, then to Fish and Judy Creek, then through Inigok to the Ikpikpuk, back over to the Colville to Umiat, down through the Itkillik, back and forth in a circle, then up to Teshekpuk Lake. I go on both sides of the river. By April the fur isn’t so great, so I go home.” (SRB&A 2003)

Several Barrow families have relatives living in Nuiqsut, and people move back and forth between the two communities. Barrow residents have ancestral ties to areas between Barrow and Nuiqsut, and people continue to return to those areas for subsistence activities at traditionally used places. Barrow hunters use the Plan Area primarily for caribou, moose, and furbearers (wolf and wolverine). This area is used in both summer (boat) and winter (snowmobile).

According to the 2003 interview data (SRB&A 2003), Barrow hunters occasionally use the Kalikpik-Kogru rivers area for caribou, especially if caribou are not available closer to Barrow. The interviewed hunters traveled by boat as far as the Kogru River. It is likely that other Barrow hunters travel further east. This area is both an historic and current use area for several Barrow families. The Colville River Delta is on the eastern edge of use area. Barrow residents make use of the Fish and Judy creeks area for caribou, wolf, wolverine, and fox. Access to this area is primarily by snowmobile in winter. Hunters use cabins and camps near Teshekpuk Lake and along the Ikpikpuk and Chipp rivers as bases for snowmobile travel.

In addition to the harvest of resources, use of these areas is important to Barrow residents for maintaining connection to family history, graves, structures, caches, ice cellars, campsites and traditional harvest areas. Although there are high costs in fuel, time, equipment, and effort for these trips, the cultural connection to these traditional areas is strong.

ATQASUK SUBSISTENCE ACTIVITIES

The village of Atqasuk is situated on the banks of the Meade River, 60 air miles south of Barrow. Near the site of several former settlements used in prehistoric and historic times, the current village is situated near a coal mine that provided fuel for Barrow during and after World War II, when the village was known as Meade River. The area is rich in caribou, fish, and waterfowl, and hunters access areas of the coast for seals and other marine resources. Some Atqasuk hunters are members of Barrow and Wainwright whaling crews and take part in bowhead whaling and festivities, returning with shares after a successful harvest.

CONTEMPORARY SEASONAL ROUND

Atqasuk subsistence harvests rely on a diversity of seasonally abundant resources that hunters must harvest when available. Some species, like ptarmigan, could be present year-round, but are only harvested when encountered. December and January are often not productive months for subsistence resource pursuits because of the winter weather and seasonal darkness. Between February and April, fur trappers travel along trapline routes to harvest wolves, foxes, and wolverines. In late February and through March, some residents begin fishing under the ice on the Meade River, its tributaries, and any lakes that do not freeze completely. Hunters may harvest caribou if they are encountered at this time, and the need to harvest more caribou could increase through March as late fall supplies are depleted. The harvest of caribou increases as daylight increases and the weather becomes increasingly moderate. Some residents may travel to Barrow or Wainwright to participate in spring whaling. Beginning in May, hunters pursue migrating birds and caribou. The break-up of river ice and lack of snow in June make travel difficult. After the ice goes out, gill-netters harvest fish near the community as the fish move upriver to spawn. The high water on the rivers and lakes of the area in late spring and early summer allows the most extensive boat travel. Later in the summer, the water levels could be too low to allow long-range travel, so community residents plan their travels for late June through July. Subsistence resources are particularly abundant from July through September. Hunters harvest caribou, grizzly bears, moose, squirrels, and migratory birds throughout the summer. By October, migratory birds have left the area, and hunters shift their focus to caribou and fish. In November, hunters attempt to harvest enough caribou for the upcoming winter, and fish have left most of the lakes for the deep river channels to overwinter. Table 3.4.3-7 depicts the annual cycle of subsistence activities at Atqasuk.

TABLE 3.4.3-7 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – ATQASUK

	Winter					Spring		Summer			Fall	
	Nov	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Fish	▒							▒	■	■	■	■
Birds/Eggs	▒	▒	▒	▒	▒	■	■	▒	▒	▒	▒	▒
Berries							▒	▒	▒	▒		
Moose							▒	■	■	■	▒	
Caribou	■	▒	▒	■	■	■	■	▒	▒	■	■	■
Furbearers	▒	▒	■	■	■	▒						

Source: Schneider et al. 1980; SRB&A 2003.
Notes:

	No to Very Low Levels of Subsistence Activity
▒	Low to Medium Levels of Subsistence Activity
■	High Levels of Subsistence Activity

SUBSISTENCE HARVESTS

Atqasuk is similar to Nuiqsut in that residents harvest caribou, fish, and birds locally; however, Atqasuk is more connected to Barrow and Wainwright for marine mammal harvests and membership in whaling crews (Hepa et al. 1997). Limited subsistence harvest data are available for Atqasuk (Tables 3.4.3-7 through 3.4.3-9). Neither the ADF&G nor the MMS have reported these data, and the NSB Department of Wildlife Management has reported only harvest data for one harvest year (1994 to 1995) (Hepa et al. 1997) and only participation data for 1992 (Fuller and George 1999). The NSB has collected 3 years of additional harvest data for Atqasuk that have not been published to date. A final report is expected by the spring of 2005. For 1994 to 1995, 57 percent of the harvest by edible pounds consisted of caribou, with 37 percent fish, 3 percent birds, 2 percent marine mammals, and 1 percent plants. Atqasuk residents harvested caribou primarily within 10 miles of Atqasuk, with the majority harvested between July and December (Hepa et al. 1997, Figures 6 and 8, Appendix 7). Residents harvested fish between June and November, with the greatest number of fish harvested between August and October (Hepa et al. 1997). Subsistence hunters at Atqasuk harvested 279 birds in May, 8 seals in July, and 84 gallons of berries between July and September (Hepa et al. 1997) (Table 3.4.3-8). Other subsistence foods could be received as shares, traded, or bartered within the community and with other villages (Hepa et al. 1997). In 1994 to 1995, 91 percent of Atqasuk households shared their harvested resources (Table 3.4.3-9). Between October and May, hunters of furbearers harvested 2 wolves, 10 wolverines, and 6 ground squirrels (Hepa et al. 1997).

Most Atqasuk residents participated in subsistence activities and shared subsistence resource harvests. Of the interviewed households in 1994 to 1995, 77 percent of residents attempted and/or succeeded in harvesting subsistence resources (Hepa et al. 1997). Fuller and George (1999) report similar participation rate information for the 1992 harvest year. Of those successfully harvesting subsistence resources in 1994 to 1995, 91 percent shared their resources with others and four percent did not. It was not known if the remaining 5 percent of Atqasuk households shared subsistence resources (Hepa et al. 1997).

TABLE 3.4.3-8 ATQASUK SUBSISTENCE HARVEST TOTALS, ACTUAL AND ESTIMATED FOR 1994-1995

Harvest Items	Total Number Harvested for 40 Households	Estimated Total Number Harvested for 56 Households
Whitefish	1,400	1,960
Broad Whitefish	1,630	2,282
Burbot	162	227
Grayling	5,716	8,002
Humpback Whitefish	500	700
Rainbow Trout	15	21
Silver Salmon	10	14
Salmonberries (Gal)	72	101
Blueberries (Gal)	12	17
White Fronted Goose	76	106
Goose Unidentified	168	235
Canada Goose	2	3
Brant	5	7
Eider Unidentified	12	17
Ptarmigan	16	22
Caribou	187	262
Ground Squirrel	6	8
Wolf	2	3
Wolverine	10	14
Ringed Seal	4	6
Bearded Seal	4	6

Sources: Hepa et al. 1997; SRB&A 2003.

TABLE 3.4.3-9 ATQASUK SUBSISTENCE HARVESTS PARTICIPATION FOR 1994-1995

Harvest Participation		Harvest Instances Resulting in Sharing	
Successful Harvest	74%	Shared	91%
Attempted, not Successful	3%	Did Not Share	4%
Did not attempt	23%	Unknown	5%

Sources: Hepa et al. 1997; SRB&A 2003.

CONTEMPORARY SUBSISTENCE USE AREAS

Subsistence hunters at Atqasuk use harvest locations relatively close to the village, with some use of the coast west of Barrow and of Dease Inlet (Hepa, Brower, and Bates 1997: Appendix 7; Schneider, Pederson, and Libbey 1980). The main advantages of Atqasuk's location are access to riverine and lacustrine resources, and position in the migration path of the Teshekpuk caribou herd (Schneider, Pederson, and Libbey 1980: 78-80). Based on Pedersen (1979), Atqasuk's 1970s subsistence use area is shown on Figure 3.4.3.2-26 and extends from northeast of Wainwright to Barrow, along the coast to the vicinity of Smith Bay, south along the Ikpikpuk River to the Titaluk River, and west and north to Peard Bay.

ATQASUK SUBSISTENCE USE AREAS EAST OF THE COMMUNITY

In August 2003, SRB&A interviewed seven subsistence harvesters in Atqasuk. One of the purposes of these interviews was to learn if Atqasuk residents currently used the Kogru and Kalikpik rivers, Fish and Judy creeks, or Colville River Delta for subsistence activities. SRB&A coordinated the interviews with the ICAS, which identified knowledgeable Atqasuk subsistence users for these interviews. The interviews focused on areas east of Atqasuk and did not specifically address current subsistence uses north, south, or west of Atqasuk.

Based on SRB&A interviews of subsistence users in Atqasuk, the recent (last 10 years) use area has expanded as compared to the use area depicted by Pedersen (1979) and extends from the eastern edge of Teshekpuk Lake in the east to the Kaolak River in the west, the Inaru River in the north, and beyond the Colville River in the south (Figure 3.4.3.2-27). Several Atqasuk residents have ties to the Smith Bay-Cape Halkett–Kogru River areas, and some of these residents intensively used the area north and southeast of Teshekpuk Lake in their youth. One hunter stated that there were “numerous small camps and villages along the coast between Drew Point, Smith Bay, and Dease Inlet. It was a [caribou] grazing area.” He explained that there were a lot of ice cellars at spot between Ikpikpuk River and Teshekpuk Lake at a spot named Shubjat. Several families had ice cellars in this area because it was high, dry ground and away from the coast where polar bears, with their keen sense of smell, would dig up the coastal ice cellars (SRB&A 2003).

Based on the 2003 interviews, Atqasuk hunters traveled east as far as Fish and Judy creeks (Figure 3.4.3.2-27). Resources sought in the eastern portion of the current Atqasuk use area include fish in the Ikpikpuk River and lakes west of Teshekpuk Lake, in the winter, and winter wolf, wolverine, and caribou. The harvest of caribou in this eastern area is incidental to the pursuit of wolves and wolverines. This pursuit of wolf and wolverine with incidental caribou harvests takes Atqasuk hunters far from the community on several extended trips each winter. During the summer and fall, subsistence use areas for caribou, fish, berries, and waterfowl are primarily centered around Atqasuk, generally within 50 miles of the community. The harvest of resources near Atqasuk, both in the summer and winter, consists of day trips involving snowmobiles, all-terrain vehicles, and boats, dependent on season. However, one subsistence user who was interviewed said he would go to one harvest area for a week, and then he would go home for a week or two, gas up and go to another harvest area.

It is not uncommon for winter hunters on snowmobiles to encounter hunters from other communities. At these junctures, the hunting area of one community overlaps with the hunting area from another community. One Atqasuk hunter who took several long winter hunting trips said that he does not go to the area above Umiat. He stated that he leaves “that country to those guys in Nuiqsut. They come up and hunt all over that area in moose season.” (SRB&A 2003) The limited Atqasuk interviews indicated that Atqasuk hunters do not hunt currently in the Nuiqsut or Colville River areas but only travel to Nuiqsut for special occasions, such as funerals, and do not use that area for subsistence purposes.

Atqasuk residents harvest most resources near their community. Furbearer hunters travel the furthest from Atqasuk and also harvest incidental caribou during these trips. Atqasuk hunters encounter furbearer and caribou hunters from other communities on these extensive travels. The area of the Kalikpik and Kogru rivers is occasionally used by Atqasuk hunters traveling by snowmobile primarily in search of wolf and wolverine in winter. The area is “homeland” for several Atqasuk families, and in the past they traveled by boat and harvested caribou, birds, and fish in this area. According to the interviews, Atqasuk residents make little use of the Colville River Delta. Atqasuk hunters occasionally use the Fish and Judy creeks area primarily for wolf and wolverine hunting in winter. Caribou could be taken incidental to furbearer hunting. Hunters make use of camps and cabins belonging to hunters, often relatives, from other communities to support their hunting trips.

ANAKTUVUK PASS

Anaktuvuk Pass is just south of the continental divide in a low pass connecting the drainages of the Anaktuvuk and John rivers, 60 miles west of the Dalton Highway. The area has been used by the interior Inupiat people called the Nunamiut for at least 500 years and by Inupiat predecessor groups for at least 4,000 years. The modern village began in 1949 with the establishment of a trading post, followed by a post office in 1951 and a church in 1958.

Residents incorporated as a fourth class city in 1959. A permanent school was established in 1961, and the community was reclassified as a second-class city in 1971 (Hall, Gerlach, and Blackman 1985).

The Nunamiut people of Anaktuvuk Pass are among the few in the NSB without direct access to marine mammals. As a consequence, the Inupiat of this village rely heavily on terrestrial mammals and fish for subsistence. Caribou is the main terrestrial mammal resource, with moose and Dall sheep also important species for hunters. Freshwater fish from area lakes and streams are an important supplement to terrestrial mammals. Terrestrial resources are often bartered with other communities, particularly Nuiqsut and Barrow, for marine resources (Brower and Opie 1996, Fuller and George 1999).

Hall, Gerlach, and Blackman (1985) have divided the history of the people of Anaktuvuk Pass into seven periods: prehistoric (before 1860), protohistoric (1860-1890), pre-removal historic (1890-1920), the coastal hiatus (1920-1934), the return (1934-1949), settlement (1949-1960) and mechanization (1960-1984). This structuring of events revolves around the arrival of Euro-Americans, the historic depopulation of the Brooks Range and interior in response to environmental and historical events, and the resettlement of those areas.

Euro-American contact beginning in the nineteenth century and the cyclical nature of the environment (e.g. fluctuations in caribou herds) worked together to change the Nunamiut way of life from the protohistoric through the coastal hiatus periods. A caribou population crash and the advent of commercial whaling in the latter half of the nineteenth century; sustained contact with Euro-Americans; the introduction of new technology (such as rifles), trade goods (flour, tea, sugar, coffee), and diseases, and the integration of Inupiat people into the world economic system (commercial whaling and later fur trapping) all had effects on the Inupiat of the interior. The result of these changes was that many were drawn to the coast through the Colville River area. Many Nunamiut dispersed along the coast to participate in commercial whaling and fur trapping, and to access the greater abundance and diversity of subsistence and imported resources in the coastal areas. Others moved towards Fort Yukon and the Mackenzie River area, where the porcupine herd was more numerous than the western arctic caribou herd (Hall, Gerlach, and Blackman 1985).

Following the decline of commercial whaling that ended by 1910, falling fur prices in the 1930s, and the steady rebound in western arctic caribou populations, Inupiat people returned to the Brooks Range in the late 1930s. Many followed the Colville River back to Anaktuvuk Pass, a location preferred by Nunamiut people for its ready access to caribou, moose, Dall sheep, and fish. A trading post was built in Anaktuvuk Pass, and then a school, which became the nucleus of a community that drew in Nunamiut people from several communities in the Brooks Range. The maintenance of the subsistence way of life from a sedentary village was partially facilitated by the use of a variety of all terrain vehicles to replace pack dogs. These all terrain vehicles include snowmobiles, four-, six-, and eight-wheeled vehicles, and tracked vehicles (Hall, Gerlach, and Blackman 1985).

CONTEMPORARY SEASONAL ROUND

Caribou hunting is the mainstay of the Nunamiut subsistence hunt, and caribou are hunted year-round as needed, but in particular August through November. The caribou migrate through the Anaktuvuk Pass area twice a year, in the spring and fall, but the number and timing of the caribou migrating through the area vary from year to year. The 1994 to 1995 harvest year was one such anomalous yearwhen the migrations were small and the summer availability was high—a time when the caribou are normally out on the coastal plain for insect relief (Brower and Opie 1996). Dall sheep, brown bear, and moose are hunted in August, September, and October some distance from the village, with Dall sheep the main target and the others secondary (Brower and Opie 1996). Birds and fish are supplementary to terrestrial mammals, but are harvested when available and are more important if caribou numbers are low (Brower and Opie 1996). Berries are seasonally important, with salmonberries and blueberries providing the majority of vegetable foods (Brower and Opie 1996). Table 3.4.3-10 depicts the annual cycle of subsistence activities at Anakluvuk Pass.

TABLE 3.4.3-10 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – ANAKTUVUK PASS

	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Caribou	▒	▒			▒	▒	▒	▒	■	■	▒	▒
Sheep										■	▒	
Moose										■		
Ptarmigan	▒			■	■	■						
Furbearers		▒	▒	■	■							
Fish						▒	▒	▒	■	■	▒	
Berries										■		

Source: Brower and Opie 1996; SRB&A 2003a.

Notes:

	No to Very Low Levels of Subsistence Activity
▒	Low to Medium Levels of Subsistence Activity
■	High Levels of Subsistence Activity

SUBSISTENCE HARVESTS

As mentioned previously, Anaktuvuk Pass is unlike the other NSB communities in that resource users there have no direct access to the marine mammal resource that in many ways defines the Inupiat of the coast. The data below indicate that terrestrial mammals are the most important resource, with nearly three-fourths of the community participating in the harvest of land mammals, which compose 88 to 95 percent of the harvest (Table 3.4.3-11) Caribou are the main terrestrial mammal species harvested, with moose and sheep also harvested in small numbers (Table 3.4.3-12). Fish are a smaller component of the subsistence diet by weight but are an important food source. Fish species harvested include grayling, arctic char, lake trout, burbot, and pike. Birds harvested during the brief migration include a variety of geese and ducks. Preferred species are white-fronted and Canada geese and several species of small ducks such as pintails. Vegetation harvested includes berries and *masu*, or "Eskimo potatoes." (SRB&A 2003)

TABLE 3.4.3-11 ANAKTUVUK PASS SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES

Resource	**Percentage of Households**					**Estimated Harvest**				
	Use	**Try to Harvest**	**Harvest**	**Receive**	**Give**	**Number**	**Total Pounds**	**Mean HH Pounds**	**Per Capita Pounds**	**% Total Harvest**
1992										
All resources							85,040	1,076	315	100
Fish		67				4,892	6,897	87	26	8
Land mammals		74				771	74,412	942	276	88
Marine mammals		1				0	0	0	0	0
Birds/eggs		21				733	913	12	3	1
Vegetation		68				607	2,818	36	10	3
1994-1995										
All resources		62	61		75					100
Fish						1,282				4
Land mammals						424				95
Marine mammals						0				0
Birds/eggs						196				>1
Vegetation						21				>1

Source: Brower and Opie 1996; Fuller and George 1999; SRB&A 2003

TABLE 3.4.3-12 SELECTED ANAKTUVUK PASS SUBSISTENCE HARVESTS

Study Year	Resource	Estimated Harvest				
		Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% Total Harvest
1990[a]	Caribou	592	69,964	985	223	
1991[a]	Caribou	545	66,712	940	245	
1992[a]	Caribou	600	70,222	889	260	83
	Dall sheep	32	3,168	40	12	4
	Grayling	3709	2,967	38	11	4
	Lake trout	531	2,124	27	8	3
	Arctic char	640	1,791	23	7	2
1993	Caribou	574	67,713	846	219	
1994-1995	Caribou	322				83
	Dall sheep	27				13
	Grayling	931				1
	Lake trout	80				1
	Arctic char	215				1

Source: ADF&G, 2001; Brower and Opie 1996; Fuller and George 1999; SRB&A 2003
Note: [a] ADF&G surveys for 1990, 1991, and 1993 were confined to caribou.

SUBSISTENCE USE AREAS

Anaktuvuk Pass hunters rely heavily on terrestrial mammals and to a lesser extent on fish. One of the important factors contributing to the resettlement of the area was the seasonal migration of caribou through the pass. A formerly used harvest strategy was herding small groups of the migrating caribou into lakes, streams, or valleys to limit their mobility and then harvesting and processing the caribou in a cooperative group undertaking (Spearman 1979). While waiting for the caribou to be herded through these areas, members of the group would fish in the streams and lakes. Anaktuvuk Pass hunters bartered furs and dried caribou for other resources, such as marine mammal fats and hides, with coastal people at trade fairs in the Colville River Delta, Barrow, and Barter Island. Anaktuvuk Pass people trade subsistence resources and access to traditional subsistence use areas with Nuiqsut people in much the same manner as they did during traditional times, only now they use contemporary transportation (Ahtuangaruak 2001 [Liberty scoping]; Hall, Gerlach, and Blackman 1985; Spearman 1984).

Harvest areas indicated in the most recent data from the NSB emphasize use areas within approximately 20 miles of Anaktuvuk Pass, with most trips taken in the immediate vicinity of the community (Brower and Opie 1996). Lifetime subsistence use areas (as depicted in Hall, Gerlach, and Blackman 1985) encompass the entire NSB from Aklavik, Canada, to Kivalina and Kotzebue Sound, and north to Point Barrow and Wainwright. Some traveled to Fort Yukon, Wiseman, and Old Crow trapping and working seasonal jobs (Brower and Opie 1996). Travel corridors and trapping areas included the Sagavanirktok and Colville rivers and the coast between the Colville River Delta and Demarcation Point (Hall, Gerlach, and Blackman 1985, Volume II).

In August 2003, SRB&A interviewed 12 subsistence harvesters in Anaktuvuk Pass. One purpose of these interviews was to learn if Anaktuvuk Pass residents used the Colville River Delta area for subsistence activities. SRB&A coordinated with the City of Anaktuvuk Pass, which identified knowledgeable Anaktuvuk Pass subsistence users for these interviews.

Resource users interviewed by SRB&A in Anaktuvuk Pass used the valleys and slopes of the Brooks Range Mountains between the Killik River valley and Itkillik Lake, with some resource users having gone farther east and west on occasion. Most resource users did not go farther south than the Alatna, Hunt Fork, and North Fork Rivers, although some had made trips to Bettles in the past. North of the Brooks Range, resource users traveled by snowmobile and all-terrain vehicle along the front slope of the mountains east to Itkillik Lake, west to Chandler

River, north to Rooftop Ridge, and parallel the Colville River past Umiat to the Chandler and Killik rivers, then headed back south into the mountains. Periodic trips to Nuiqsut were made along the east or west side of the Anaktuvuk River almost to its confluence with the Colville, then headed east towards the Kuparuk hills, and north to Nuiqsut along the cat trail that roughly parallels the Itkillik River (Figure 3.4.3.2-28).

CONTEMPORARY CONNECTIONS TO NUIQSUT, THE COLVILLE RIVER AREA, AND THE BEAUFORT SEA COAST

Anaktuvuk Pass residents have numerous connections to Nuiqsut, the Colville River area, and the Beaufort Sea. These connections include relatives who live in Nuiqsut, persons or persons with relatives who were born and raised along the Colville and now reside in Anaktuvuk Pass, hunting for caribou in the Nuiqsut area during times of scarcity at Anaktuvuk Pass, hunting for wolf and wolverine during trips to Nuiqsut, trading and exchanging with coastal residents, and attending funerals.

Many residents have relatives and friends residing in Nuiqsut, Kaktovik, and Barrow, as well as other North Slope communities. Some Anaktuvuk Pass residents moved into the community at different ages and maintained connections to the communities they came from, including Fort Yukon, Shungnak, Barrow, and Fairbanks. Others grew up or had relatives who grew up along the Colville River and the Beaufort Sea coast and moved to Anaktuvuk Pass after the community was established. Two lifetime Anaktuvuk Pass residents described their several trips to Nuiqsut in the 1970s. They said they mostly went to Nuiqsut for funerals. One of these persons stated, “Our fathers grew up in the flat country, we didn’t, but our fathers did. They could travel anytime, even at night and never get lost. We never grew up in the flats; we are mountain men.” (SRB&A 2003)

Coastal residents trade food, furs, and other goods with Anaktuvuk Pass residents in exchange for dry meat and other Nunamiut specialties. Some Anaktuvuk Pass residents receive marine mammal products from friends and relatives in coastal communities as “care packages.” (SRB&A 2003) Anaktuvuk Pass ties to the coast were particularly evident with one harvester who was born in Barrow and had lived the last 30 years in Anaktuvuk Pass. This person said, “I eat both foods: coastal (seal oil, seal, walrus, white fish) and Nunamiut/inland food (caribou, moose, freshwater fish [grayling, char, lake trout, ling cod], edible plants, and berries.” (SRB&A 2003)

Periodic shortages of caribou and other game have made living inland a difficult proposition for Inupiat people for centuries and required them to follow the caribou migration year-round. In the late 1940s, the Nunamiut settled into Anaktuvuk Pass from Chandler Lake, Killik River, and Tuluġaq Lake partially in response to the requirement for children to attend school. A result of sedentary life was the increased difficulty resource users experienced in harvesting adequate amounts of subsistence foods, even with modern transportation and other equipment. An added complication was the establishment of the Gates of the Arctic National Park and Preserve, which has restricted the use of certain all-terrain vehicles (such as Argos and four-wheelers) at certain times of the year (snow-free). This has restricted Nunamiut from accessing subsistence areas in snow-free months that they formerly occupied and used (SRB&A 2003).

Several times in the 1970s and 1980s, and as recently as 1994 and 1998, Anaktuvuk Pass residents found it necessary to travel great distances to procure enough caribou to feed their community. The NSB has paid for some trips, using charters and float planes to fly hunters from Anaktuvuk Pass to places like Umiat and Schrader Lake (located approximately 60 miles southwest of Kaktovik) (SRB&A 2003). More recently, hunters have traveled to Nuiqsut to harvest caribou for Anaktuvuk Pass (Figure 3.4.3.2-28), and on other occasions Nuiqsut hunters have provided caribou, fish, and other coastal foods during lean times. Anaktuvuk Pass resource users reciprocate with gifts of dry meat and other Nunamiut specialties.

A lifetime Anaktuvuk Pass hunter, describing his winter trail to Nuiqsut, indicated he traveled in February or March and hunted as he traveled. He said that he generally hunted along the trail and did not go back and forth hunting off the trail, but used his binoculars to look out to the sides of the trail for game. He said he went to Nuiqsut once or twice a year and indicated that he did not do any fishing on the way to Nuiqsut; just wolf and wolverine hunting. He said his trips had a dual purpose: to hunt and to visit relatives that include cousins, aunts, and uncles in Nuiqsut. He generally stayed in Nuiqsut less than a week. He said that he put 6,000 miles on his snowmobile in six months.

Another Anaktuvuk Pass hunter harvested 15 to 20 caribou on a trip to Nuiqsut in 1998. He indicated that he harvested considerable caribou each year and said, “I hunt mostly in the winter time; it is easier. That is when the caribou are pretty fat. I hunt mostly in winter when there is snow on the ground; you can go further. The summer time you cannot go too much unless you have a good Argo. My dad has one.” He said that he received marine mammals from Nuiqsut and Barrow when they send them up. He stated, “Also from Wainwright when they catch a whale; they send some in a box.” (SRB&A 2003)

There is competition between hunters and communities in the pursuit of wolves, wolverines, and foxes. Several Anaktuvuk Pass hunters have traveled north to Nuiqsut, and along the route they hunt wolf, wolverine, and caribou. One hunter said, “I hunted everything on my trip to Nuiqsut.” This hunter described the trip to Nuiqsut as “one camp” away. In other words, he left Anaktuvuk Pass, made camp for one night, and went to Nuiqsut the next day. He said, “It is not that far.” Other hunters remarked similarly on the route, noting important landmarks and features along the way. One hunter had harvested wolf and wolverine near Ocean Point in 1998. While residents of several communities encounter each other while hunting furbearers, it was often noted that “it is better for them to see your tracks than for you to see theirs,” as often the tracks of other hunters was a sign that the animal being sought had already been taken or run off by the other hunter (SRB&A 2003).

In summary, Anaktuvuk Pass residents have hunted caribou, wolf, and wolverine along their winter travel routes north from near the confluence of the Anaktuvuk and Colville rivers all the way to Nuiqsut (Figure 3.4.3.2-28). In summer, Anaktuvuk Pass residents have hunted for caribou along the Colville River, past Ocean Point, and down the Nigliq Channel to the Beaufort Sea. They have also hunted summer caribou down the main channel of the Colville River to Anajuk Point. They have fished in the main channel of the Colville near Itkillikpaat (Figure 3.4.3.2-28).

3.4.4 Environmental Justice

Environmental Justice (EJ) refers to the considerations mandated by Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-income Populations. The Executive Order requires analysis to identify communities characterized by minority and low-income populations that could be subject to disproportionate human health or environmental effects of a proposed federal action, which in this case is approval of the development of the ASDP. Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut are North Slope communities that are in proximity to and could be affected by the proposed ASDP.

To determine if the population of these communities would be characterized as minority and low-income populations, the USEPA has defined guidelines for comparing socioeconomic characteristics of the potentially affected communities to a reference population. If the local potentially affected communities have minority or low-income characteristics that are higher than the reference population, then they are further evaluated to determine if potential impacts of the proposed project are disproportionately borne by these same local communities (or populations). Because there are no other larger population centers on the North Slope to serve as a reference population, State of Alaska average socioeconomic characteristics were selected as the reasonable reference population.

The USEPA guidelines suggest that if a community exhibits ethnic or economic characteristics that are a minimum of 1.2 times the state average for these same characteristics, that the community or local population is considered an EJ population (EPA 1998). The ethnic composition of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut are shown in Table 3.4.4-1. This table shows that all four communities would be classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. The statewide population is 15.4 percent American Indian and Alaska Native. The communities considered range from 56 percent in Barrow to 94 percent in Atqasuk, or from approximately 4 to 6 times greater minority composition than the State of Alaska as a whole. This ratio is considerably greater than the minimum guideline of 1.2 suggested by the USEPA. On the basis of the much higher percentage of minority composition in the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut than in the state as a whole, an evaluation of disproportionate impacts of the ASDP is required.

TABLE 3.4.4-1 ETHNIC COMPOSITION OF ANAKTUVUK PASS, ATQASUK, BARROW, AND NUIQSUT IN 2000 – PERCENT BY RACE

	State of Alaska		Anaktuvuk Pass		Atqasuk		Barrow		Nuiqsut	
	Population	**Percent**	**Population**	**Percent**	**Population**	**Percent**	**Population**	**Percent**	**Population**	**Percent**
Total	626,932	100.0%	282	100.0%	228	100.0%	4,581	100.0%	433	100.0%
Hispanic or Latino	25,852	4.1%	2	0.7%	0	0.0%	153	3.3%	1	0.2%
Not Hispanic or Latino:	601,080	95.9%	280	99.3%	228	100.0%	4,428	96.7%	432	99.8%
Population of one race:	570,626	91.0%	280	99.3%	227	99.6%	4,063	88.7%	429	99.1%
White	423,788	67.6%	27	9.6%	11	4.8%	972	21.2%	44	10.2%
Black or African-American	21,073	3.4%	4	1.4%	0	0.0%	44	1.0%	1	0.2%
American Indian or Alaska Native	96,505	15.4%	247	87.6%	215	94.3%	2,558	55.8%	382	88.2%
Asian	24,741	3.9%	0	0.0%	1	0.4%	429	9.4%	2	0.5%
Native Hawaiian and Pacific Islander	3,181	0.5%	0	0.0%	0	0.0%	59	1.3%	0	0.0%
Some other race	1,388	0.2%	2	0.7%	0	0.0%	1	0.0%	0	0.0%
Two or more races	30,454	4.9%	2	0.7%	1	0.4%	365	8.0%	3	0.7%

Source: ADOL 2000, Census Table SF-1.

3.4.5 Cultural Resources

3.4.5.1 Introduction

This section discusses cultural resources of the Arctic Coastal Plain, with particular emphasis on the Colville River Delta and the eastern National Petroleum Reserve-Alaska area. Cultural resources include sites and materials of prehistoric Native American, historic European and Euro-American, and historic Inupiat origin (for example, traditional cabin sites, camp sites, and burial grounds). The Cultural Resources section also includes a discussion of cultural resources of the Arctic Coast including traditional subsistence harvest sites and other traditional land uses areas, landscapes, symbols, and place names. This section also discusses continued access to archaeological and historical sites.

This analysis relies on the following sources:

- Alaska Heritage Resource Survey (AHRS) files located at the Office of History and Archaeology
- The NSB's TLUI (NSB 1980)
- An assessment of literature pertaining to cultural resources in the proposed project area

The discussion of prehistoric and historic resources in the Plan Area will be divided into three facility group areas that include (1) the Colville River Delta Facility Group including Nuiqsut; (2) the Fish-Judy Creeks Facility Group, which includes Fish and Judy creeks and the National Petroleum Reserve-Alaska planning area to the south and southeast of these creeks; and (3) the Kalikpik-Kogru Rivers Facility Group, which encompasses the west and northwest area of the northeast portion of the National Petroleum Reserve-Alaska planning area.

The analysis of cultural resources is based on the following:

- Cultural resources are generally assumed to be eligible or potentially eligible for the National Register of Historic Places (NRHP) unless stated otherwise.
- Information for this section relies on available information from existing literature and database resources and inventories.
- From a regulatory perspective, "historic properties" meet the criteria for inclusion in the NRHP by the National Historic Preservation Act (NHPA). Many sites meet the broader definition of "cultural resources," such as AHRS and TLUI sites, which individually would or would not be NRHP-eligible or listed but are nevertheless of cultural importance.

3.4.5.2 Cultural Resources Environment

Knowledge of northern human inhabitants has been recorded for approximately 150 years, and attempts at understanding cultural history of the area began in earnest at the turn of the twentieth century (Lobdell and Lobdell 2000). The Arctic Coastal Plain and the Beaufort Sea coastline have been the subjects of intensive archaeological investigations since 1979. During this time, it has been noted that interior portions of the Arctic Coastal Plain are relatively stable; however, the Beaufort Sea coastline has been subject to fairly rapid change, with an average of 3 m per year succumbing to erosion (Lobdell and Lobdell 2000). In the interior portions of the Arctic Coastal Plain, landforms that could encourage human habitation have yielded evidence of prehistoric and historic occupation. These landforms include pingos, south-facing bluff overlooks above narrow valleys or canyons adjacent to major river systems, and wet or moist meadow tundra (Lobdell and Lobdell 2000). Riverine and stream localities with pronounced banks and terraces and lakeshores of especially large lakes (such as Teshekpuk Lake) or lakes with well-developed basin ridges have proven to be places of past human use (Lobdell and Lobdell 2000).

PREHISTORIC ENVIRONMENT (BEFORE 11,000 YEARS AGO TO AD 1827)

Beginning approximately 12,500 years ago, a warming period brought increased moisture, vegetation, and dune stabilization to the North Slope. During this time, cottonwood trees and shrub tundra vegetation expanded beyond their modern limits. This warm period was interrupted approximately 11,000 years ago by a return to ice-age conditions. This period, termed the Younger Dryas interval, is marked in arctic Alaska by the reactivation of the dune fields, a retraction of cottonwood trees, and a lowering of lake levels. Vegetation was likely cold steppe, and the climate was colder and drier than current conditions. Large mammals that are now extinct in the area (mammoth, horse, bison, lion) dominated the landscape. By 10,000 years ago, the climate began to return to that of before the Younger Dryas interval. The large mammals that had dominated the landscape became extinct, lake levels rose, the ranges of peat and vegetation such as cottonwood expanded, and numerous thaw-lakes developed. By 8,500 years ago, the dune fields were stable and poorly drained, and peaty modern soils were established (Mann et al. 2002, in Reanier 2002).

OVERVIEW OF REGIONAL PREHISTORY

Human prehistory on the north coast of Alaska is represented by isolated localities along the coast of the Beaufort Sea from Point Barrow to the Canadian border near Demarcation Point. The oldest archaeological site that has been documented near the project area was discovered on a pingo frost feature southwest of Deadhorse, Alaska. This archaeological site is associated with the Northern Archaic culture and dates to approximately 6,000 years ago. The earliest sites in the Plan Area are undated and have been assigned to the prehistoric period. These include Puriksuk (HAR-165), Nigliq (HAR-169), and two lithic sites (HAR-022 and HAR-009). The following descriptions outline prehistoric traditions in the region which, based on locations of their documented remains, have potential for occurring in the project area. The cultural history and human development sequences of northern Alaska are incomplete. Table 3.4.5-1 depicts a provisional cultural sequence for Northern Alaska.

PALEOINDIAN/PALEO-ARCTIC (11,000 B.P. TO 7,000 B.P.)

The earliest sites in northern Alaska date to the end of the Pleistocene and beginning of the Holocene, approximately 11,000 years ago, and can be placed in two categories, Paleoindian and Paleo-Arctic. The early prehistory of the North Slope area has been documented at the Putu and Bedwell sites on the North Slope of the Brooks Range. The cultural remains from these sites were initially designated as two separate entities; however, the sites appear to be segments of a single site (Reanier 1996). Putu/Bedwell contain the first Paleoindian-related artifacts to be discovered in Alaska, as well as Paleo-Arctic artifacts (Reanier 1996). The Hilltop site is above the Atigun River and contains Paleoindian artifacts similar to those found at the Mesa site. The site dates to 10,400 years ago (Reanier 1995, in Reanier 2000). Available dates indicate that the early occupation of Putu/Bedwell could be 9,000 to 10,000 years in age. Dates from the Mesa site, 200 miles to the west and south of Putu/Bedwell, corroborate this age range. Close parallels can be seen in the artifact types found at the Putu/Bedwell and Mesa sites. In addition, the range for the Mesa artifacts of 9,700 to 11,700 years ago substantially overlaps with the problematic dates from Putu/Bedwell (Kunz and Reanier 1996). Sites such as Putu/Bedwell and Mesa contain cultural remains that could contribute to research questions associated with the ways in which humans adapted to environments of the high latitudes in North America and the arrival of humans in the region at the Pleistocene-Holocene boundary.

TABLE 3.4.5-1 PROVISIONAL CULTURAL SEQUENCE FOR NORTHERN ALASKA

Tradition	Date	Finds	Representative Sites
Historic Inupiat	A.D. 1826	Stone, metal, trade goods, organic artifacts plus historic, ethnographic and informant accounts	Historic Coastal and Riverine Inupiat
Late Prehistoric (Birnirk, Thule)	2,000 B.P.-A.D. 1826	Lithic, wood, leather, bone artifacts, house ruins	Pingok Island, Thetis Island, Niglik, Birnirk, Walakpa, Point Hope, Cape Krusenstern, Nunagiak, Utqibġvik, Nuwuk
Arctic Small Tool (Denbigh, Choris, Norton, Ipiutak)	4,500-1,200 B.P.	Diminutive lithic microtools, cores, burins, blades	Putuligayuk River, Central Creek Pingo, Onion Portage, Mosquito Lake, Choris, Walakpa, Iyatayet, Point Hope, Coffin, Jack's Last Pingo
Northern Archaic	6,000-3,000 B.P.	Side-notched points, microblades, bone tools	Putuligayuk River, Kuparuk Pingo, Kurupa Lake, Tuktu
Paleo-Arctic	10,000-7,000 B.P.	Cores and blades, microcores, microtools, bifaces	Putuligayuk River, Jones Pingo, Gallagher Flint Station, Lisburne, Tunalik
Paleoindian	12,000-9,800 B.P.	Extinct fauna, large lanceolate points, bifaces	Mesa, Bedwell, Putu, Hilltop

Source: Lobdell and Lobdell 2000: Table 2; Reanier 2002: Table 1
B.P. = Before Present

NORTHERN ARCHAIC (6,000 B.P. TO 3,000 B.P.)

The Northern Archaic culture appeared approximately 6,000 years ago in many areas of Alaska (Reanier 2002; Lobdell and Lobdell 2000). Most Northern Archaic artifacts found throughout the Arctic Foothills and the Brooks Range are surface finds (Lobdell and Lobdell 2000). Northern Archaic groups are believed to have been primarily hunters of large terrestrial animals.

Northern Archaic sites in the vicinity of the project area include the Putuligayuk River Delta Overlook site at Prudhoe Bay, the Kuparuk Pingo site, Kurupa Lake in the foothills of the Brooks Range, and the Tuktu site north of Anaktuvuk Pass (Lobdell 1995; Lobdell and Lobdell 2000; Reanier 2002). The Putuligayuk River Delta Overlook site contains artifacts associated with the Northern Archaic culture. The Kuparuk Pingo site is within a few miles of the Beaufort Sea shore and approximately 30 miles west of the Putuligayuk River Overlook site. This pingo location is unusual because these ice core hill features on the Arctic Coastal Plain landscape were not believed to persist for more than a "few millennia" from the time of their initial development until they submerged into the plain (Lobdell 1995, p. 62). However, evidence provided by radiometric age determination and artifacts associated with the Northern Archaic culture indicates that the landform has been in existence for at least 6,000 years. The location of the site adjacent to the north Alaska coast indicates that Northern Archaic people possibly used coastal resources in addition to the terrestrial fauna long believed to be the primary focus of Northern Archaic subsistence (Lobdell 1995).

Northern Archaic remains in the Brooks Range include an assemblage from the Tuktu site north of Anaktuvuk Pass that is designated as the Tuktu complex and dates to as early as 6,500 years in age (Lobdell 1995). The occurrence of Northern Archaic remains at Anaktuvuk Pass indicates that Northern Archaic people used the Arctic Coastal Plain, as well as the mountain passes through the Brooks Range. The Kurupa Lake site is in the foothills of the Brooks Range and dates to as early as 6,600 years ago (Schoenberg 1995, in Reanier 2002).

ARCTIC SMALL TOOL TRADITION (4,500 B.P. TO 1,200 B.P.)

The Arctic Small Tool Tradition (ASTt) initially appeared in Alaska approximately 4,800 years ago at Cape Denbigh and Kuzitrin Lake in the central Seward Peninsula (Harritt 1994). ASTt is generally believed to be the earliest archaeological tradition associated with modern Inupiat people (Reanier 2002). Several cultures are associated with ASTt including Denbigh, Choris, Norton, and Ipiutak.

Denbigh is the earliest component of ASTt and dates to 4,800 years ago on the Seward Peninsula (Harritt 1994). The youngest date for Denbigh, approximately 2,000 years ago, comes from the Mosquito Lake site in the northern foothills of the Brooks Range. Denbigh houses are similar to the contact-period Inupiat houses observed by contact-period Russian and American explorers. Denbigh people hunted large game and harvested the salmon that appeared in the streams during the summer runs. Coastal Denbigh sites, and some of the technology associated with them, indicate that Denbigh people hunted seals as well (Anderson 1984, Giddings 1964). Denbigh sites near the project area are documented from northern coastal areas to the Arctic Foothills and pass through the Brooks Range (Lobdell 1995).

Denbigh-related sites occur near Prudhoe Bay at the Putulagayuk River Delta Overlook site (Lobdell 1995). A Denbigh-related site also occurs at Central Creek Pingo, an ancient ice core mountain on the Arctic Coastal Plain, approximately 3 miles from Prudhoe Bay and a mile inland from the Beaufort Sea coast (Lobdell 1995). Radiocarbon dates from this location range from 4,000 to 3,500 years ago (Lobdell 1995).

Denbigh occurrences at locations between the northern coast and the Brooks Range have been termed “tundra Denbigh.” Denbigh is documented at Mosquito Lake, near Galbraith Lake on the northern slopes of the Brooks Range. The age of Mosquito Lake Denbigh is placed at approximately 2,500 years, based on three radiometric determinations (Kunz 1977). This age appears to some researchers to be too young for Denbigh culture in northern Alaska. However, radiocarbon dates of Denbigh components from Tukuto Lake, in the Arctic Foothills, range from roughly 4,400 to 3,300 and 2,200 to 1,600 years in age. The Tukuto Lake Denbigh dates define a temporal range into which the Mosquito Lake occupation fits and indicate that Denbigh culture persisted in the area between the northern coast and the passes through the Brooks Range from 4,400 to 1,600 years ago.

Following Denbigh, the Choris culture appeared in coastal areas of northwest Alaska from 3,700 to 500 years ago. Choris cultural remains have been documented on the North Slope of the Brooks Range dating from 2,700 to 2,500 years in age. Elements of the Choris culture, named after the type site in eastern Kotzebue Sound, have been documented as far inland as Anaktuvuk Pass and Galbraith Lake (Anderson 1984). Assigning Choris origins to the northern interior Alaskan occurrences is less certain than is desirable, and there remains a possibility that the assemblages represent an unnamed cultural tradition (Anderson 1984). Other Choris sites on the North Slope include the Walakpa site, which has been dated to between 3,400 and 2,300 years ago, and the Coffin site (Stanford 1976, in Reanier 2002).

The Norton culture was first defined at the Iyatayet site on Norton Sound and spans a time period from approximately 2,500 to 2,000 years ago. Cultural remains documented at Norton sites suggest that the Norton culture has its origins in the Choris culture (Giddings 1964). At Point Hope, cultural remains identified as Near Ipiutak were found that are identical to those associated with the Norton culture.

The Ipiutak culture is believed by some prehistorians to have contributed to the development of Thule culture. The Ipiutak site at Point Hope was characteristic of the Ipiutak culture. Ipiutak lacked pottery, ground slate tools, and stone lamps, which are associated with the earlier Norton culture and later Inupiat cultures. Ipiutak sites have been documented both coastal and inland. The presence of Ipiutak sites in the Brooks Range and its temporal position immediately preceding Thule indicate that Ipiutak culture played a significant role in the prehistory of the area. Inland Ipiutak persisted substantially longer than the presence of the culture in coastal areas. Coastal age ranges fall within the period from 2,000 to approximately 1,100 years ago, while those of the interior fall within the period from 1,350 to 550 years ago (Gerlach and Hall 1988, Giddings and Anderson 1986). Ipiutak remains in the Brooks Range and in Anaktuvuk Pass are predominantly those of temporary encampments, but sparse occurrences of small settlements are known, such as those represented by houses at Etivluk and Feniak lakes and the Toyuk site southwest of Anaktuvuk Pass.

LATE HOLOCENE ORIGINS OF THE HISTORIC CULTURES (2,000 B.P. TO A.D. 1827)

Beginning approximately 2,000 years ago, ancestral forms of the historic Native cultures emerged and underwent the final stages of development leading up to the cultural forms that were encountered by European explorers in the nineteenth century.

From the Birnirk period onward, the cultural continuity of arctic peoples into the twenty-first century is well established. The Birnirk phase, a direct ancestor of the historic Thule culture, appears in the Bering Strait by 1,600 years ago. Birnirk peoples lived in semisubterranean winter houses and engaged in the harvest of marine and land mammals, birds, and fish. The Birnirk type-site is located near Barrow at the base of the Barrow spit. Other sites that contain Birnirk cultural remains include Walakpa, Point Hope, and Cape Krusenstern. Birnirk-style artifacts have been found from northeastern Siberia to northwestern Canada, indicating a large trade network reminiscent of the extensive Inupiat trade network in place in the nineteenth century.

Thule is the immediate prehistoric ancestor of the various historic Inupiat groups. Approximately 1,000 years ago, a favorable climate coupled with technological innovations such as the umiaq (a large skin boat), the qataq (cold trap door for winter houses), and the umiat (dog sled) resulted in the rapid expansion of Thule populations from the Bering Strait along the shores of the Beaufort Sea to Greenland, and southeast around the shores of the Bering Sea ultimately to Kodiak Island and Prince William Sound. Developed Thule appeared by 1,000 years ago and persisted in the North American Arctic to historic contact, between 1800 and 1850 (Collins 1964, Giddings and Anderson 1986). When the early explorers and whalers arrived on the Beaufort Sea coast in 1826, they encountered the Thule people. Thule people hunted sea mammals, including whales, as well as terrestrial game such as caribou. In many Thule areas, salmon were also an important subsistence resource. Thule sites at Barrow include Nuvuk, Utkiagvik, Thetis Island (destroyed), Pingok Island, and Nigliq.

PREHISTORIC RESOURCES IN THE PLAN AREA

Four prehistoric sites are within the project area. These resources are described in Table 3.4.5-2 and discussed by facility group area below. It should be noted that the lack of documented prehistoric sites in these facility group areas does not preclude the existence of undocumented prehistoric sites in those areas.

COLVILLE RIVER DELTA FACILITIES GROUP

There is one documented prehistoric site in the Colville River Delta Facility Group. The site of Nigliq (HAR-169, TLUI-58, TLUIHAR-084) contains prehistoric artifacts, as well as historic artifacts. Nigliq means “goose,” and this site was a vital link in the aboriginal trade and commerce network from prehistoric times (Hoffman et al. 1988). Trade fairs at this site continued into the early twentieth century.

FISH-JUDY CREEKS FACILITIES GROUP

There is one documented prehistoric site in the Fish-Judy Creeks Facility Group. The site of Puviksuk (Puviqsuq) (HAR-165, TLUI 76) is first mentioned in Nunamiut creation mythology as the knoll where the giant Ayagumaphaq (Aiyagomahala) built his snow house so that he would be remembered through the generations. The snow house turned into a small knoll with a hollow on top where he left his pack (Hoffman et al. 1988). Prehistoric artifacts, including a lithic component, fire-cracked rock, and hearths, as well as historic sod house ruins and a shaman’s grave, are present at the site. Puviqsuq means “it’s swelling up.” The site has also served as a travel landmark over the generations.

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP

AHRS #	TLUI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Colville River Delta Facility Group									
HAR-008							grave	grave	
HAR-052						Historic, Euro-American (post AD 1951-1972)	sod house foundation or tent ring with modern debris that could relate to temporary navigation system set up at VABM Nehi	sod house foundation/ tent ring with modern debris (electrical wire, copper antenna ground rod)	
HAR-054				Nechelik Channel Lifeboat		Historic			
HAR-055							isolated find	caribou bone	3
HAR-056				Ivik Grave		Historic	Ivik grave (1924)	grave	2
HAR-155	63	TLUIHAR-080	Hall #2264	Uyagagvik	"place where one can get many rocks"	Historic and contemporary Inupiat	site, quarry, fish camp	none	4,5,6
HAR-156	60	TLUIHAR-083	Hall #2263	Nanuk	"polar bear"	Historic Inupiat, first half of 20th century	site, reindeer herding station, sod houses, storage pits, sod quarries	sod houses, ice cellars, reindeer corral	3,4,6,8
HAR-157	45		Hall #2273	Niglivik 2		Historic Inupiat	site, sod house, cache pit, sod quarry	sod house, cache pit	3
HAR-158	80			Putu	"hole"	Historic and contemporary Inupiat	site, hunting camp, settlement, sod houses, sod quarry, cellar	sod houses, ice cellar	2,3,6,7
HAR-159	88		Campbell (#33)	Nuiqsutpiat		Historic and contemporary Inupiat	site, fishing/trapping camp, sod houses, ice cellar, sod quarries, tent area	sod houses, ice cellar, sod quarries, tent area	1,2,3,4,5
HAR-160	89		Campbell (#32) (Also in AHRS as HAR-043)	Niglinaat	"place of the white-fronted geese"	Historic (1930s) and contemporary (1970s) Inupiat	fishing, trapping camp	sod houses	2,3,4,6,8

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TL UI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Colville River Delta Facility Group (cont'd)									
HAR-162				Aanayyuk (Anajuk, Anayuk)	Anajuk means "a man who died there"	Historic Inupiat			
HAR-169[a]	58, 6	TLUIHA R-084		Niglik/Woods Inaat (Camp)	Nigliq means "goose"	Prehistoric, historic, and contemporary Inupiat	site, trading settlement, burials, fish camp	sod houses, smokehouse, cabins, storage pits, grave	2,3,4,5,6,7,10
	57			Tulagvik	"where a boat goes ashore"		fishing, hunting, trapping area		4,5,6
	59			Apkugaruk	"old trail"		fishing area		4
	61			Nuiqsut			fishing, trapping, hunting, camping area, graves (cemetery)	graves/cemetery	2,4,5,6
	62			Tulugaluk	"old raven"		fishing, hunting, camping, trapping area		4,5,6
	79			Sigiaruk			fishing, hunting, and camping area		4,6
	82			Napaun			fishing, hunting, and camping area, sod house ruins	sod house ruins	3,6,8
	85			Milugiak	name of a fish or "fish with mouth under"		fishing, nesting, hunting, root harvesting area		4,8
	86			Illaktugvik			fishing and nesting area, cabins, graves	cabins, graves	1,2,4,8
	87			Nauyaatuuq	"seagulls"		fishing and nesting area		4,8

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TLUI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Colville River Delta Facility Group (cont'd)									
		TLUIHAR-075[b]							
		TLUIHAR-077[b]							
		TLUIHAR-078[b]							
		TLUIHAR-079[b]							
		TLUIHAR-081[b]							
		TLUIHAR-082[b]							
		TLUIHAR-085[b]							
Fish and Judy Creeks Facility Group									
HAR-004	70	TLUIHAR-067		Kitik (Qitiq)	"pulverized stone"	Historic Inupiat	site, quarry		8
HAR-005							sod house and boat on Fish Creek		3
HAR-010				Kikkaq	"gully"	Historic Inupiat (AD 1970s)	site, camp site, marker	marker (wood and stone)	6
HAR-028	55	TLUIHAR-086	NSB CRSI #2250, Hall #2250	Nukruapaitch (Niaquqturuq)		Historic Inupiat (20th century)	site, hunting and camping area (site could have been destroyed), sleds, beluga butchering locality	sleds, upright poles, beluga bones	3,6
HAR-044						Recent Inupiat	recently attended grave (reburial of surface-scattered human remains) marked and outlined (remains of old coffin a few meters east of the grave), mound of unexplained origin, driftwood marker	grave/reburial marked and outlined, remains of old coffin, mound, driftwood marker	2

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TL UI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Fish and Judy Creeks Facility Group (cont'd)									
HAR-053						Historic Inupiat	site, isolated surface find, human remains	isolated surface find, human remains	2
HAR-163	3			Itkillikpaat, Itqilippaa	"at the mouth of the Indian River"	Historic and contemporary Inupiat	site, fish camp, sod house ruins, sod house, cemetery, sod quarries, tent rings, storage pits	sod houses, storehouses, cemetery	2,3,4,5,6
HAR-164	77	TLUIHA R-072	Hall #2268	Tiragroak, Tirragruaq	"large sandbar"	Historic and contemporary Inupiat	site, fish camp, camp, sod houses, cache pits, historic remains	sod houses, storage pits	3,4,7
HAR-165	76	TLUIHA R-071	Hall#2267	Puviksuk, Puviqsuq	"it's swelling up"	Prehistoric/Historic Inupiat	creation site, hunting, camping, fishing	sod house ruins, lithics, grave	2,3,4,6,10
HAR-166	75	TLUIHA R-070	Hall#2266	Aki, Agki Creek	"the other side" (of a lake or river)	Historic and contemporary Inupiat	site, hunting, camping, fishing	sod house ruins	3,4,6
HAR-167	74	TLUIHA R-069	Hall #2265	Kayukisiluk, Kayuqtusilik	Kayuqtusilik means " a place where there are red foxes"	Historic Inupiat/Euro-American, first half of 20th century	site, trading post, storehouse, sod house ruins, graves, tent rings, ice cellars, refuse mounds	wood frame trading post storehouse, sod house ruins, ice cellars, graves, tent rings, refuse mounds	2,3,7
HAR-168				Aqsiataaq Inaat		Historic Inupiat (A.D. 1930s-1940s)	site, camp, moss house, historic remains	moss house, historic remains	3,6
	1	TLUIHA R-088	Hall #2237	Ugiin		Historic	cabins, sod house ruins, winter furbearer hunting	cabins, sod house ruins	1,3,6
	54			Niaquqturuq			fishing, duck hunting and nesting area, sod house ruins	sod house ruins	3,4,6,8
	68			Kastialurak			fishing, berry harvesting and hunting area		4,6,8

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TL UI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Fish and Judy Creeks Facility Group (cont'd)									
	71			Kuugruachiak			fishing, hunting and camping area		4,6
	72			Illanikruak, Ilannik			fishing and trapping area		4,5
	78			Kayaktuagiak			fishing, hunting and camping area		4,6
	81			Ittigiak	Ocean Point		hunting, berry harvesting		6,8
		TLUIHA R-040		Ayuvioa	Place name derived from a person		hunting area		6
		TLUIHA R-041		Silulium Paawa	Entry or mouth of the Siulik River		fishing and hunting area		4,6
		TLUIHA R-044		Ikpitchiaq	"a newly formed hill"		hunting area		6
		TLUIHA R-063[b]							
		TLUIHA R-064[b]							
		TLUIHA R-065[b]							
		TLUIHA R-068[b]							
		TLUIHA R-073[b]							
		TLUIHA R-087[b]							

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TLUI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Kalikpik and Kogru Rivers Facility Group									
HAR-002			Hall #2278			Prehistoric	site, lithic remains (destroyed?)		
HAR-007		TLUIHAR-061					reindeer herding driftwood fence and tent platform	reindeer fence, tent platform	6,11
HAR-009						Prehistoric	site, isolated find (lithic)		
HAR-012	46	TLUIHAR-029	Hall #2244	Aki, Agki		Historic Inupiat (AD - 1920s)	site, sod house ruins (one belonged to Ugruaq)	sod house (3) ruins	3
HAR-013				Uguak		Historic Inupiat	site, sod house, house pits, cabins	sod house, house pits, cabins	1,3
HAR-014			Hall #2279			Historic Inupiat (AD - 1930s)	structure, reindeer corral, house pit	structure, reindeer corral, house pit	3,11
HAR-018				Ahsogeak Site		Historic Inupiat	site, habitation, historic remains		6
HAR-022	49	TLUIHAR-016	NSB CRSI #2245, Hall#2245	Saktui, Sakitui, Saktuina Point, Saktui Islands		Historic	former site of Edwardsen's Trading Post, sod houses and graves, site of former fishing area	sod houses and one or more graves (most of site destroyed by erosion)	2,3
HAR-024	50	TLUIHAR-090	Hall #2246	Qiqiktag		Historic Inupiat	Site, tent site	tent site	6
HAR-025	51		Hall #2247	Tikigaqmiut (Tikiragmiut, Eskimo Islands)		Historic Inupiat	site, "old cemetery of Point Hope people…"		2

TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

AHRS #	TL UI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Kalikpik and Kogru Rivers Facility Group (cont'd)									
HAR-026	52	TLUIHA R-091	Hall #2248	Atigaru Point (Atigruk Point, Amaulik)		Historic Inupiat	site, graves, sod house ruins, tent sites		2,3,6
HAR-027	53		NSB CRSI #2249, Hall #2249	Kanigluq		Historic Inupiat	site, sod houses (1977 TLUI 7 sod house ruins), ice cellar	sod houses, ice cellar	3,7
HAR-029	56		NSB CRSI #2251, Hall #2251	Ikkalipik		Historic Inupiat	site, sod house, ruins (destroyed/ not located – see HAR-030)	none	
HAR-030						Historic Inupiat (20th century)	site, settlement, sod house (may be actual location of Ikkalikpik [HAR-029])	sod house (4 x 2.5m), stakes and posts (boat rack), caribou bones, hearth	3
HAR-045						Historic Inupiat (20th century)	site, camp site, racks and old boats (mostly destroyed), possible sod removal area	campsite, boat racks, old boats (mostly destroyed), upright tentstakes, sod removal area	6
HAR-046						Historic Inupiat (20th century)	site, campsite, boat rack and old boats, possible tenting area	campsite, boat rack and old boats (Nantucket-style whaling long boat), tenting area	6

Table 3.4.5-2 Alaska Heritage Resources Survey and Traditional Land Uses Inventory – Cultural Sites by ASDP Facility Group (cont'd)

AHRS #	TL UI #	TLUI # (2003)	Other Site #	Site Name	English Translation	Time Period	Site Type/Description	Cultural Remains	TLUI Legend
Kalikpik and Kogru Rivers Facility Group (cont'd)									
HAR-051						Historic Inupiat (20th century)	Site, historic remains	historic remains (stove parts, driftwood posts, rusted steel cans, caribou bones, hide pegs) found on stabilized sand dunes west of the creek on which HAR-030 is located (may be associated)	6
HAR-058				USC&GS memorial		Historic	USC&GS bronze memorial for Kay, Grenell, and Roberts (lost at sea)		
	48	TLUIHA R-013		Nuyapisut			trapping and hunting area, place for gathering driftwood		5,8
		TLUIHA R-014		Kiputit			fishing, trapping, nesting, and hunting area		4,5,6,8
		TLUIHA R-021		Kuugruk	Kuugruk River		fishing, hunting, and eider nesting area		4,6,8
		TLUIHA R-036		Kuugruk	Kuugruk River		fishing, hunting, and eider nesting area		4,6,8
		TLUIHA R-038		Savikpaligauram Ioitublia			fishing and hunting area	sod house ruins	3,4,6
		TLUIHA R-039		Sikulium Kuuwa	Sikulik River		fishing and hunting area		4,6
		TLUIHAR-059[b]							
		TLUIHAR-060[b]							
		TLUIHAR-062[b]							
		TLUIHAR-089[b]							

Source: Department of Natural Resources, Office of History and Archaeology 2003; NSB 2003
Notes: (see next page)

[a] National Register of Historic Places
[b] No information available
USC&GS = U.S. Coastal and Geodetic Survey
Traditional Land Use Inventory (TLUI) Legend (Based on NSB template):
1 = Cabins/Shelter Cabins Today
2 = Graves/Cemetery
4 = Fishing
3 = Ruins/Sod Houses/Bones
5 = Trapping Area
6 = Hunting/Camping Area
7 = Cellars
8 = other/Nesting Area, Seals, Roots
9 = Whaling Settlement
10 = Important Event/Old Site
11 = Reindeer Herding Area

KALIKPIK-KOGRU RIVERS FACILITIES GROUP

There are two documented prehistoric site in the Kalikpik-Kogru Rivers Facility Group. One prehistoric site (HAR-002) contained lithic cultural remains, as well as cut antler, bird bone, and an ivory harpoon head, and may have been destroyed by erosion (Ito-Adler and Hall 1986). The second prehistoric site (HAR-009) consisted of an isolated lithic cultural remain.

3.4.5.3 Overview of Regional History

EUROPEAN/EURO-AMERICAN EXPANSION, EXPLORATION, AND ETHNOGRAPHIC RESEARCH

The exploratory period on the North Slope began in 1826 with the first Franklin expedition. Sir John Franklin and his crewmembers sailed westward from the Mackenzie River to the Return Islands just west of Prudhoe Bay and spent 1825 through 1826 at Herschel and Barter islands. That same year, Frederick William Beechey's expedition sailed north from the Bering Strait to Point Barrow. Franklin, as well as other early explorers, noted that the presence of European trade goods (such as tobacco, iron, and copper) preceded their arrival among the Inupiat on the North Slope. In 1837, Thomas Simpson of the Hudson's Bay Company traveled from the east to Point Barrow. In 1849, Lieutenant W.J.S. Pullen, of the *HMS Plover*, surveyed the Arctic coast from Wainwright Inlet to the McKenzie River. Between 1847 and 1854, contact between Europeans and the Inupiat increased because of the influx of whalers to the region, and exploration of the region increased as ships searched for the lost Franklin expedition. From 1852 to 1853, R. Maguire, of the *HMS Plover*, wintered at Point Barrow. Richard Collinson, a captain on one of the search ships looking for Franklin's lost expedition, collected Inupiat place names for areas along the coast from Barrow to the Mackenzie River while wintered off the ice of Camden Bay between 1853 and 1854 (Schneider and Libbey 1979).

During the commercial whaling period, items such as metal and firearms became increasingly important as part of Inupiat material culture. By the 1850s, guns were in use by local Inupiat people; and by the 1880s, Inupiat whalers were using commercial whaling darting guns and bombs. Beginning in 1881, J. Murdoch and Lieutenant P.H. Ray, members of the International Polar Expedition, collected ethnographic information over the course of 2 years at Point Barrow. During the last quarter of the nineteenth century, epidemic diseases caused a severe population decline among the North Slope Inupiat. By the end of the nineteenth century, major population shifts occurred as a result of disease and famine. Declines in caribou populations resulted in famine that caused inland Inupiat to leave their homes and relocate to coastal communities such as Barrow, where coastal Inupiat populations had declined from diseases such as smallpox and influenza (Reanier 2002).

Interest in the geology and history of the early culture of the area began in earnest at the beginning of the twentieth century, but was limited by access to coastal areas. Vilhjalmur Stefansson conducted ethnographic studies along the coast east of Barrow between 1906 and 1907, 1908 to 1912, and 1913 to 1918. Between 1906 and 1914, Ernest de Koven Leffingwell conducted geographical place name research in the Arctic. As an extension of the Fifth Thule Expedition, Knud Rasmussen crossed into Alaska from Canada in 1924. He compiled ethnographic data on the Alaskan Inupiat and their camps and recorded place names on the Utukok River. In 1952, Robert F. Spencer investigated the ecological relationship between inland and coastal Inupiat groups. Various researchers, including Rausch, Ingstad, Gubser, and Binford, studied the Nunamiut (or inland Inupiat).

The initiation of petroleum development led to intensive investigations of cultural resources on the North Slope. These investigations occurred after World War II in the Naval Petroleum Reserve No. 4 (currently designated the National Petroleum Reserve-Alaska), which was created in 1923, and before and during construction of the TAPS. The NSB Commission on History and Culture began the TLUIs for the North Slope in the 1970s in anticipation of and in response to increased resource development on the North Slope (Schneider and Libbey 1979). This program is discussed in greater detail below.

MISSIONARY EFFORTS, TRADING POSTS, AND REINDEER HERDING

Christian missionaries first arrived in Barrow in 1890. Because of the efforts of Christian missionaries and evangelization by the Inupiat, Christianity was nearly universal by 1910 (Reanier 2002). Mission schools were established between 1890 and 1910 at Wales, Point Hope, and Barrow, as well as other places that were not previously occupied year-round. Eventually, the original mission schools split into separate entities—government schools and church-operated missions. Trading posts were set up near the missions and schools. These areas became focal points for the Native population, and settlements grew up around each one (Schneider and Libbey 1979).

At the end of the nineteenth century, Sheldon Jackson, a Presbyterian missionary, introduced reindeer herding to Alaska Natives. Following the collapse of the commercial whaling industry, the people of Wainwright and Barrow developed and maintained large herds of reindeer. Reindeer herds were maintained by Inupiat in the vicinity of Wainwright, Barrow, and Nuiqsut, as well as other settlements on the North Slope (Schneider and Libbey 1979). Reindeer herding ended in 1938 because of the collapse of the market for meat and hides (Reanier 2002).

At the beginning of the twentieth century, whale oil, and whalebone (baleen) decreased in importance. The fur trade filled some of the economic gap left by the collapse of the whalebone market and the subsequent demise of commercial whaling. In 1915, the Barrow whaler and trader Charles Brower ceased commercial whaling operations to begin fur trading operations. It was common practice for white traders to fund Natives in the establishment of outposts. For example, the trading post at Kayiktusiluk on the Colville River was financed by Jack Smith and operated by Thomas Ichuagak, a Colville River Delta Inupiat (Schneider and Libbey 1979). For the Inupiat, trading traditionally has had social and economic importance. Trading posts in the area began to cease operation in the 1930s as a result of the Great Depression and reduced fur demand, and many were replaced by village stores. Most of the trading posts had ceased operations by the 1940s (Schneider and Libbey 1979).

3.4.5.4 Community History

NUIQSUT

Nuiqsut is on the Nigliq Channel on the west side of the Colville River Delta. The Nuiqsut area provides a diverse seasonal abundance of terrestrial mammals, fish, birds, and other resources and is a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (ADCED 2003). The name Nuiqsut recalls prehistoric and historic camps and settlements occupied by many families on the main channel of the Colville that had been used traditionally as an area for hunting, fishing, trapping, and trading. The people of Nuiqsut call themselves Kukpikmiut, or the People of the lower Colville River (Brown 1979). Most residents in the area moved to Barrow when the Bureau of Indian Affairs mandated school attendance for children in the 1940s. However, former residents continued to use the Colville River area for subsistence purposes. The passage of ANCSA in 1971 led to the reestablishment of the community. In April 1973, the community of Nuiqsut was resettled by 27 families who embarked on a 150-mile trek from Barrow to the Colville River. Many of these people had lived in the Colville River area 25 to 30 years earlier and were “seeking an alternative to the accelerating urbanization of Barrow.” (Libbey et al. 1979)

BARROW

Barrow has been occupied for approximately 4,000 years, with continuous occupation for the last 1,300 years (Dumond 1977). The earliest occupants of the Barrow area were bearers of the Birnirk culture. The Inupiat name for the Barrow area is Utqiagviq, meaning “the place where we hunt snowy owls.” Because Barrow is situated on a point of land where the sea ice is prone to cracking, the main subsistence focus has been marine mammal hunting, particularly whaling. In recent years, Barrow has been the social and economic center for the North Slope Inupiat (with trade, commercial whaling, schools, NSB administration, and wage employment).

ATQASUK

The village of Atqasuk is on the banks of the Meade River, 60 air miles south of Barrow. The Atqasuk area is rich in caribou, fish, and waterfowl, and hunters access areas of the coast for seals and other marine resources. The Atqasuk area is the location of several former settlements used in prehistoric and historic times. The current village site is near a coal mine that provided fuel for Barrow during and after World War II. At that time, the village was known as Meade River.

HISTORIC RESOURCES/TLUI SITES IN THE PLAN AREA

In general, coastal Inupiat from the prehistoric period and later (through current times) have settled in small villages on peninsulas or points of land where conditions are ideal for sea mammal hunting and have traveled inland for caribou, fish, and furbearers on the river systems. The relationship of the Inupiat to their natural environment remains a cornerstone of their personal and group identity (NSB 1979). Signs of past occupation (such as remains of camps or houses) generally mark historical places of significance. Old occupation sites are not regarded by the Inupiat as being truly abandoned, but are valued by the Inupiat as the living and dying places of ancestors “no longer recalled but still a part of the surrounding world” (NSB 1979), and could have supernatural associations that affect the way they are used by modern populations. Cultural associations with the land could be contained in recollections of the recent past, stories of remote history or “folklore,” and in supernatural beliefs (NSB 1979). Oral traditions and supernatural beliefs are connected to specific features of the landscape or “connected to locations where remote historical events involving the people, the animals and the landforms took place.” The Inupiat believe that “each place is entirely unique and imbued with its own importance.” (NSB 1979, p. 29)

Historic resources located in the area potentially affected by the proposed project or near the Plan Area are listed and briefly described in Table 3.4.5-2. There are 11 documented historic sites (listed as “Historic” under the Time Period subheading) in the Colville River Delta Facility Group area; 11 documented historic sites in the Fish-Judy Creeks Facility Group area; and 15 documented historic sites in the Kalikpik-Kogru Rivers Facility Group area. It should be noted that undocumented historic sites might be located in these areas.

TRADITIONAL LAND USES INVENTORY

Place names and traditional land uses sites in the mid-Beaufort Sea region generally refer to locations where important events or activities, frequently subsistence use, took place (Lobdell and Lobdell 2000, NSB 2003). Lobdell and Lobdell (2000, p. 35) state that place names “reflect an ‘ethnohistoric present’ or a living memory of the past. Without written records, this rich component of oral tradition may extend back three to four generations or even beyond.”

A description of TLUI sites is provided in Table 3.4.5-2. There are 25 documented TLUI sites in the Colville River Delta Facility Group; there are 29 documented TLUI sites in the Fish-Judy Creeks Facility Group; and there are 21 documented TLUI sites in the Kalikpik-Kogru Rivers Facility Group. The existing literature that describes TLUI sites in the mid-Beaufort Sea region is not consistent in how TLUI sites and their associated numbers are expressed. Thus, Table 3.4.5-2 lists a variety of numbers for each TLUI (for example, TLUI [1979], TLUI [2003], AHRS #, and Other Site #). The table provides a description of the TLUI sites using the TLUI (1979) and TLUI (2003) numbers, AHRS number, and the site name/place name (Inupiat and English) where applicable.

3.4.6 Land Uses and Coastal Management

3.4.6.1 Land Ownership

Land ownership on the North Slope and within the Plan Area has been affected by several land laws including the Native Allotment Act, Alaska Statehood Act, ANCSA, ANILCA, and the Naval Petroleum Reserves production Acto of 1976 (NPRPA). Table 3.4.6-1 shows the approximate acres for the different ownerships in the Plan Area and Figure 3.4.6.1-1 depicts land status.

FEDERAL LANDS

The BLM manages 560,900 acres within the National Petroleum Reserve-Alaska. Management responsibilities for this land was transferred to the DOI and delegated to the BLM in 1976 by the NPRPA. Under ANCSA, as amended, Kuukpik and ASRC have selection rights within the National Petroleum Reserve-Alaska.

STATE LANDS

The State of Alaska owns 103,220 acres and has selected an additional 1,280 acres for a total of 104,500 acres in the Plan Area. Most of these lands occur in the lower portion of the Colville River Delta. Alaska Department of Natural Resources (ADNR) manages the state lands within the Plan Area.

NATIVE LANDS

Kuukpik Corporation owns approximately 222,100 acres within the Plan Area. ASRC holds the subsurface estate under these lands and must consult with Kuukpik prior to sale or lease of any subsurface resources. These lands are located in both the Colville River Delta, along the main and Nigliq channels, and in the eastern portion of National Petroleum Reserve-Alaska.

OTHER PRIVATE LANDS

There are approximately 2,500 acres of privately owned lands in the Plan Area, most of which are Native allotments. The Plan Area also includes almost 80 acres patented to the Helmericks family in 1984.

TABLE 3.4.6-1 APPROXIMATE ACRES FOR DIFFERENT OWNERSHIPS IN THE PLAN AREA

Land Status	Acres
BLM-managed	560,900
State[1]	104,500
Kuukpik Corporation[2]	222,100
Other private[1]	2,500
TOTAL	**890,000**

Note: Ownership reflects surface ownership. Numbers are rounded.
[1] Represents selected and conveyed lands.
[2] All lands conveyed.

3.4.6.2 Current Land Uses

Land uses on the North Slope is regulated by different entities in different areas. Land uses within the National Petroleum Reserve-Alaska is regulated by the BLM through identification of special land uses areas and through lease or permit conditions. Land uses outside the National Petroleum Reserve-Alaska is subject to local government land use regulations adopted by the NSB (Title 19), as well as by coastal management programs at the state and local level. The Alaska Coastal Zone Management State Coastal Zone regulations (6 AAC 80) and the NSB Coastal Management Plan Enforceable Policies (19.70.050) regulate coastal uses in the area consistent with the federal Coastal Zone Management Act (CZMA) (16 USC 1456). Land uses on state-owned lands is further restricted via lease or permit conditions from the ADNR.

The poor soil conditions and lack of access in the Plan Area limit uses of these lands. Of the approximately 890,000 acres in the Plan Area, the Alpine Field development accounts for approximately 100 acres, the village of Nuiqsut accounts for approximately 5,900 acres, and the remaining area is undeveloped, with the exception of that used for subsistence-related camps and cabins, and that owned by the Helmericks family in the northeast part of the Colville River Delta. Oil exploration and scientific research activities occur in various locations throughout the Plan Area. Limited recreational activity occurs in the study area, as discussed further in following sections. North Slope Alaska Natives, particularly those in Nuiqsut, use the study area extensively for subsistence hunting and gathering, as previously described.

The BLM has historically authorized short-term land use permits for the following types of land uses in the portion of the Plan Area within the National Petroleum Reserve-Alaska:

- Annual overland resupply transport that uses track- or low-pressure equipped vehicles between various North Slope villages
- Activities allowed by Minimum Impact Permits, including the off-season staging of seismic equipment, clean-up of old military sites, and paleontological digging in the Colville River drainage at Ocean Point
- Annual winter geophysical research conducted by companies throughout the Plan Area
- Continued authorized research (such as revegetation at well sites and climatic studies)
- Various communications- and navigation-related activities authorized for federal agencies and private companies
- Commercial and guided hunting

In addition to these authorized uses, a number of unauthorized uses occur within the study area. These uses primarily consist of cabins and camp sites that are not on Native allotments or other Native lands. Although these cabins are not protected under any existing laws, the BLM has been consulting with the NSB about the identification and regulation of these areas.

SPECIAL AREAS, SPECIAL MANAGEMENT ZONES, AND LAND USES EMPHASIS AREAS

Certain areas of the Plan Area within the National Petroleum Reserve-Alaska have been classified as special land uses areas. Under the NPRPA, the Secretary of the Interior has broad authority to designate areas within the National Petroleum Reserve-Alaska as Special Areas. Special Areas were designated by the Secretary of the Interior pursuant to the NPRPA because they contained significant subsistence, recreational, fish and wildlife, or historical or scenic values. Petroleum exploration in the Special Areas was to be conducted in a manner that would ensure maximum protection of these values to the extent consistent with the requirements of the NPRPA (BLM and MMS 1998a).

Special Management Zones (SMZs) were a product of the BLM’s 1983 Final EIS and ROD on oil and gas development in the National Petroleum Reserve-Alaska (BLM 1983b). The 1983 FEIS and ROD identified four SMZs, three of which occur within the Plan Area: the Teshekpuk Lake SMZ; the Colville River SMZ; and the Beaufort Sea Coast SMZ. The first two of these had boundaries similar to designated Special Areas. The Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and ROD (BLM and MMS 1998b) did not retain the SMZs. The 1983 EIS also deferred leasing in the Fish Creek Delta and adjacent salt marshes to allow for further ecological study and along the Colville River to allow for a wild and scenic rivers (WSR) study.

During the planning process for the northeast portion of the National Petroleum Reserve-Alaska, the BLM identified specific areas with significant resources and designated these areas as Land Use Emphasis Areas (LUEAs). The BLM used LUEAs in the Northeast National Petroleum Reserve-Alaska IAP/EIS to identify geographic areas with important specific resources where the BLM considered management emphasis to meet its responsibilities (BLM and MMS 1998a). Several stipulations from the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD discuss restrictions associated with LUEAs (see Appendix D). The LUEA classification is not an administrative or legislative designation and does not carry regulatory authority. Figure

1.1.1-3 shows the Special Areas, Figure 3.4.6.1-2 shows the LUEAs, and Figure 3.4.6.1-3 provides a graphic representation of the oil and gas leasing stipulations.

SMZs and LUEAs are similar to Special Areas in that they were designated to identify and protect specific surface resources. They differ from Special Areas in that SMZs and LUEAs are not legislative designations and carry no regulatory authority.

SPECIAL AREAS AND SPECIAL MANAGEMENT ZONES

The 1983 Final EIS (BLM 1983a) and ROD (BLM 1983b) described the following areas in the ASDP Area:

- The TLSA had been established by the Secretary of the Interior in 1977 to minimize impacts on waterfowl.
- The CRSA had been established by the Secretary of the Interior in 1977 to minimize impacts on peregrine falcons.
- The Beaufort Sea Coast SMZ, including barrier islands within the National Petroleum Reserve-Alaska and 2 miles onshore at Elson Lagoon, the mouth of the Kalikpik River, and the Fish Creek Delta and salt marsh area, was established in the 1983 EIS to minimize impacts on waterbirds.
- In the ROD for the 1983 EIS, 200-meter setback zones were established for all rivers with subsistence fisheries.
- In the ROD for the 1983 EIS, leasing was deferred until July 1987 in the Fish Creek Delta and adjacent salt marshes to allow the USFWS the opportunity to complete ecological studies.
- In the ROD for the 1983 EIS, a 4-mile-wide corridor centered on the mid-stream of the Colville River was withdrawn from mineral development until September 1984 while Congress evaluated a recommendation to give the river WSR status.

LAND USES EMPHASIS AREAS

The 1998 Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and ROD (BLM and MMS 1998b) described the following areas in the ASDP Area. These documents superseded the decisions in the 1983 ROD (BLM 1983b). Excerpts from the 1998 ROD (BLM and MMS 1998b), including stipulations for the following areas, can be found in Appendix D of this FEIS.

- The TLSA was described as an area that encompasses important goose molting areas, caribou calving and insect-relief habitat, and all of Teshekpuk Lake. The 1998 IAP/EIS (BLM and MMS 1998a) stated that the TLSA is a long-standing subsistence area of special importance to subsistence users because of the caribou and fish resources. LUEAs within the TLSA include the Teshekpuk Lake Watershed, Goose Molting Habitat, Spectacled Eider Breeding Range, TLCH, and the portion of the Fish Habitat LUEA associated with Teshekpuk Lake and the Miguakiak River.
- The CRSA was described as an area encompassing up to 14 miles north and west of the Colville River (within the boundary of the National Petroleum Reserve-Alaska). It was created to protect the arctic peregrine falcon, listed as an endangered species when the 1983 Final EIS was published. LUEAs within the CRSA include the Colville River Raptor, Passerine, and Moose Area; the portion of the Fish Habitat LUEA associated with the Colville River; the Umiat Recreation Site; Scenic Areas; and potentially the Colville River WSR, if this designation were to be established.
- The boundary of the Teshekpuk Lake Watershed LUEA coincides with that of the TLSA within the Plan Area. This LUEA was set aside because this region is one of the most productive, diverse, and unique wetland ecosystems on the North Slope. Within the northwest portion of the Plan Area, the attributes of the Teshekpuk Lake Watershed LUEA include a complex shoreline that features bays, spits, lagoons, beaches, and shoal areas; complex water flow patterns in an extraordinarily flat landscape; deep lakes that provide overwintering habitat for fish; and numerous small streams.

- The Spectacled Eider Breeding Range LUEA, encompassed by the TLSA, was established to protect nesting and brood rearing areas for the threatened spectacled eider. Approximately 16 percent of the North Slope population of spectacled eiders nest near Teshekpuk Lake within this LUEA. The Spectacled Eider Breeding Range LUEA occurs in the northwest portion of the Plan Area.
- The TLCH LUEA, encompassed by the TLSA, was established to protect calving and insect relief habitat important to the Teshekpuk Lake caribou herd. The TLCH LUEA occurs in the northwest portion of the Plan Area.
- The Fish Habitat LUEA contains numerous water bodies that provide important spawning, migration, rearing, and overwintering habitat for anadromous and resident fish species. Within the Plan Area, the Fish Habitat LUEA includes corridors extending 0.5 mile from the west bank of the Colville River (including the river) and 0.25 mile from either bank of Fish and Judy creeks. It includes the beds of these two creeks, as well as the shores and beds of Teshekpuk Lake and other lakes west of the ASDP Area.
- The Colville River Raptor, Passerine, and Moose LUEA, within the Plan Area, extends from the eastern boundary of the National Petroleum Reserve-Alaska at approximately Ocean Point upstream to 1 mile west of the bluffs of the Colville River.

3.4.6.3 Coastal Management

Coastal management on the North Slope is governed several ways through the following: the federal CZMA (16 USC 1456), the NSB Coastal Management Program (CMP) and Land Management Regulations (LMR), and the ACMP, which includes the NSB CMP.

COASTAL ZONE MANAGEMENT ACT

The CZMA, enacted in 1972, has been amended several times, most recently in 1996. The act encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife that use those habitats. The federal program was designed to provide states an ability to participate in federal decisions for activities proposed by federal agencies, as well as activities proposed by private applicants that require a federal permit. Although participation by states is voluntary, once approved, states must implement their programs. To encourage states to participate, the act makes federal financial assistance available to any coastal state or territory that is willing to develop and implement a comprehensive coastal management program.

ALASKA COASTAL MANAGEMENT PROGRAM

The Alaska State Legislature enacted the ACMP in 1977. Since enactment, the program has been amended a number of times, including amendments passed by legislature in 2003 and submitted to the Office of Ocean and Coastal Resource Management for approval as a Routine Program Change. These most recent changes require all coastal districts to review and revise their CMPs to meet the new requirements of the ACMP, and to submit their revised CMP to ADNR by July 1, 2005. Until the revised CMP is approved by ADNR, the existing CMP remains in effect.

One of the purposes of the ACMP is to provide balanced use and protection of resources in the coastal area. The ACMP includes local coastal district programs such as the NSB CMP. Regulations provide guidelines for the program including development of local coastal district programs (6 AAC 85), reviews for consistency with the ACMP (6 AAC 50), and statewide standards (6 AAC 80). Formerly housed in the Governor’s Office, the ACMP is now the responsibility of the Office of Project Management and Permitting in the ADNR.

Projects situated in coastal areas must be consistent with enforceable policies of the ACMP. These enforceable policies include the statewide standards found in 6 AAC 80 and the enforceable policies included in coastal district programs that have been approved by the ADNR and the Office of the Ocean and Coastal Resource

Management of the U. S. Department of Commerce (USDOC.) Enforceable policies of the NSB are found in Chapter 2 of the NSB's CMP.

The entire Plan Area lies within the boundaries of the NSB. Although federal lands, including those managed by the BLM in the Plan Area, are excluded from the coastal zone under the CZMA, uses and activities on federal lands that affect state coastal zones and their resources must be consistent with the state management programs. The ACMP requires that project activities within the geographic boundaries of the state's coastal zone, including coastal areas of the National Petroleum Reserve-Alaska, must be consistent with the enforceable policies. A description of the NSB's enforceable policies follows the discussion of ACMP statewide standards below.

USES AND ACTIVITIES

Nine statewide enforceable policies are listed under the heading of Uses and Activities in the ACMP:

- Coastal development (6 AAC 80.040)
- Geophysical hazard areas (6 AAC 80.050)
- Recreation (6 AAC 80.060)
- Energy-facility siting (6 AAC 80.070)
- Transportation and utilities (6 AAC 80.080)
- Fish and seafood processing (6 AAC 80.090)
- Timber harvesting and processing (6 AAC 80.100)
- Mining and mineral processing (6 AAC 80.110)
- Subsistence (6 AAC 80.120)

RESOURCES AND HABITATS

Three statewide standards address resources and habitats: Habitats; Air, Land, and Water Quality; and Historic, Prehistoric, and Archaeological Resources.

Habitats (6 AAC 80.130)

The ACMP habitat standards apply to eight coastal habitats, as listed below:

- Offshore
- Estuaries
- Wetlands and tideflats
- Rocky islands and sea cliffs
- Barrier islands and lagoons
- Exposed high-energy coasts
- Rivers, streams, and lakes
- Important uplands

The habitat standards call for the maintenance or enhancement of the biological, physical, and chemical characteristics of these habitats. It is possible for uses and activities that do not maintain or enhance these habitats to be permitted if (1) there is a significant need; (2) there is no feasible or prudent alternative that will conform with the standard; and (3) steps are taken for maximum conformance with the standard.

Air, Land, and Water Quality (6 AAC 80.140)

This standard addresses air, land, and water quality concerns through the standards, regulations, and procedures for protecting air, land, and water quality of the ADEC. The 2003 legislation exempts the ADEC from the coordinated ACMP process for activities affecting air, land, and water quality that is subject to AS 46.40.040(b)(1). The issuance of an ADEC authorization establishes consistency with the air, land, and water quality standards in 6 AAC 80.140. For reviews of activities on federal lands and waters where the ADEC does not have an authorization, the ADNR issues the ADEC's consistency finding.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

This standard requires the identification of the areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory. The State Historic presernvation Office (SHPO) interprets this standard to mean that if an area has, or is determined likely to have cultural resources, these areas must be identified. This is accomplished through archaeological surveys, interviews with local citizens, and other research means.

The CZMA and ACMP require that the coastal uses that raise state or federal concerns be addressed as stated in the CZMA, Section 303(2)(C), AS 46.40.060, and AS 46.40.070. Under the ACMP, these activities cannot be arbitrarily or unreasonably restricted or excluded through local district management programs. Uses relevant to activities within the Plan Area include coastal development, recreation, energy facility, transportation and utilities, and subsistence.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

In 1984 the NSB adopted its CMP. The NSB CMP was then approved by the Alaska Coastal Policy Council in April 1985 and finally by the federal Office of Ocean and Coastal Resource Management in May 1988. Several revisions occurred between the adoption of the NSB CMP by the NSB and by the Alaska Coastal Policy Council. The most recent changes to the ACMP require all coastal districts to review and revise their CMPs to meet the new requirements of the ACMP, and to submit their revised CMP to ADNR by July 1, 2005. Until the revised CMP is approved by ADNR, the existing CMP remains in effect.

The NSB CMP is applicable inland to approximately 25 miles and beyond along the full length of all major river corridors, including the Colville River. The goals and objectives of the NSB CMP cover a broad range of cultural, economic, subsistence and resource issues. The CMP was developed to protect the subsistence lifestyle and culture of the Inupiat people, and to protect the natural environment, while allowing for compatible resource development to increase economic opportunities. The NSB CMP contains four categories of enforceable policies to help achieve this delicate balance:

Standards for development that prohibit severe harm to subsistence resources or activities and disturbance of cultural historic sites (CMP 2.4.3). The standards specifically state that development shall not preclude reasonable subsistence user access to subsistence resources (CMP 2.4.3(d)) nor deplete subsistence resources below the needs of the local community (CMP 2.4.3(a)). In addition, the standards require cultural resources to be avoided if possible, and require consultation and archeological investigations for those areas that cannot be avoided (CMP 2.4.3e-g).

The enforceable policies on required features for development address use of vehicles, vessels, and aircraft; engineering criteria for structures; drilling plans; oil spill control and cleanup plans; pipelines; causeways; residential development associated with resource development; air quality; water quality; and solid waste disposal. Specifically, CMP 2.4.4(a) calls for vehicles and aircraft to avoid areas where noise sensitive species are concentrated and calls for horizontal and vertical buffers where appropriate. Other sections of CMP 2.4.4 call for development to comply with state and federal regulations regarding water and air emissions, solid waste disposal, and sewage disposal (CMP 2.4.4c-e).

Best effort policies that address uses allowed if there is “significant public need for proposed use and activity” (NSB CMP 2.4.5(1)) and only if developers have “rigorously explored and objectively evaluated all feasible and prudent alternatives” and documented the reasons for elimination of other alternatives (NSB CMP 2.4.5(2)). Under the NSB CMP, development that may adversely affect resources will be allowed only if “all feasible and prudent steps to avoid the adverse impacts” have been taken (NSB CMP 2.4.5.1). This category contains policies that restrict development that could significantly affect and decrease the productivity of subsistence resources or restrict access to these resources unless they meet the conditions described above (NSB CMP 2.4.5.1a-b). Under this category, restrictions are also placed on transportation, mining development, and construction in floodplains and geological-hazard areas. Finally, the best effort policies include requirements to locate, design, and operate facilities in a manner that prevents adverse impacts on fish and wildlife and their habitats; to consolidate facilities to the greatest extent possible; to comply with State coastal management policies; to avoid impacts to cultural use areas; and to avoid impacting transportation to subsistence use areas (NSB CMP 2.4.5.2).

Minimization of negative impact policies require development to limit the amount of adverse impacts of recreational use, transportation and utility facilities, and seismic exploration on the natural environment, wildlife and subsistence. This includes maintaining natural permafrost (2.4.6c), minimizing impacts of transportation on wildlife and habitats (2.4.6b,d,e), and minimizing potential risks associated with geologic hazards (flooding, ice gouging, etc.).

In an effort to implement the coastal management policies described above, the NSB has in place a comprehensive plan and an administrative procedure established under Title 19 of the NSB Land Use Regulations that incorporate parts of the NSB CMP.

3.4.6.4 North Slope Borough Land Management Program

The North Slope Borough Comprehensive Plan and Land Management Regulations (LMRs) were first adopted in December 1982. The LMRs were later revised on April 12, 1990. As part of the 1990 amendments, the NSB incorporated the enforceable policies of the NSB CMP into the LMRs in Section 19.70.050. Other 1990 revisions included the addition of the following policy categories: Village Policies, Economic Development Policies, Offshore Development Policies, and Transportation Corridor Policies. Policies include information about both onshore and offshore oil and gas leasing activities.

These regulations are again undergoing review, and additional revisions are expected to be completed and adopted in 2004. The NSB has indicated that the revisions are being undertaken with the goals of making the regulations more reflective of local concerns and clarifying the permitting process. With the pending revisions, the NSB also proposes the addition of Subsistence Policies to the LMRs.

The NSB requires land use permits for any project that involves ground disturbance. Ground disturbance includes such things as sediment sampling, vegetation sampling, core sampling, mechanized transportation (excluding snowmobiles and four-wheelers), field camps, or any activity that is determined by the NSB Planning and Community Services Department, Permitting and Zoning Division, to constitute a ground disturbance. The applicable NSB permit within the Plan Area is the LMR permit. The LMR categorizes uses into three areas: (1) administratively approved without public review, (2) requiring a development permit and public review before they can be administratively approved, and (3) considered to be conditional development requiring approval by the Planning Commission.

The NSB LMR is considered to the extent practical in any decision by the BLM regarding federal lands. Although the local land use plans are acknowledged, they cannot prohibit activities on federal lands. All activities on federal lands must be authorized by the BLM.

3.4.7 Recreation Resources

3.4.7.1 Recreation Setting

The Plan Area is within a vast region of the Arctic and is well suited for non-winter outdoor recreation activities such as backpacking, float boating, fishing, hunting, wildlife viewing, and birding. The Colville River is known for being a gentle, slow-moving river, enabling visitors to enjoy the various scenery and wildlife along its course.

There is no developed road system into or through the Plan Area. As a result, summer recreation access to the area is almost exclusively by charter aircraft from regional locations including Deadhorse, Umiat, Barrow, and Bettles (BLM 2003). Natural features within the Plan Area such as lakes, rivers, gravel bars, and ridges serve as airstrips for these aircraft. The village of Nuiqsut has a maintained landing strip that can by used by the public (via charter flights) but is not promoted for use by nonresidents (BLM 2003). Commercial air flights are conducted by Cape Smythe Air and Frontier Flying Service, Inc. Both services have one flight per day into and out of Nuiqsut all days of the week except Sunday.

The Plan Area is vast and remote, with somewhat primitive recreational opportunities. Most of the Plan Area has characteristics of wilderness such as pristine, natural, and undisturbed landscapes. The opportunity to be isolated from the sights and sounds of other people and to feel a part of the natural environment is quite high. The area is primarily characterized by an unmodified natural environment (no developed recreation sites) with a very low concentration of recreation users and minimal interaction between groups of recreation users. There are no federal, state, or NSB recreational developments or structures in the Plan Area.

3.4.7.2 Recreation Opportunity Spectrum (ROS)

The Recreation Opportunity Spectrum (ROS) was developed for use by both the BLM and the USFWS. The BLM has adopted the ROS to recognize the different types of recreation opportunities on lands under their management. Because the use of snowmobiles and motorized boats is allowed throughout the Plan Area and because the Plan Area is located within the National Petroleum Reserve-Alaska (which is set aside for oil and gas development), the recreation experience in the Plan Area would be classified under the ROS as “semi-primitive motorized” (SPM.) (Delaney 2003, pers. comm.) This classification is characterized by predominantly natural or natural-appearing landscapes; areas that are large enough to impart a strong feeling of remoteness; few user facilities; low road density; and infrequent interaction with other visitors. (BLM 2003).

3.4.7.3 Recreation Activities and Use in the Plan Area

Little is known about specific recreation trends within the Plan Area. To obtain current recreational use information, telephone interviews were conducted with registered outfitter-guides operating within or near the Plan Area. Past or present outfitter guides were contacted to obtain information on the types of recreation occurring in the Plan Area, specifically along the Colville River, and to estimate the number of people traveling to the area in a particular recreation season.

Visitors interested in recreational opportunities choose the Colville River area for a variety of reasons, including vast wildlife populations (especially birds of prey); remoteness; the slow, meandering flow of the Colville River; fossils and geology; and general beauty. Additionally, visitors often participate in more than one activity (such as backpacking and wildlife viewing), making it difficult to estimate exact use numbers for each activity. Overall, the Colville River area is fairly unknown among recreationists who visit Alaska, and many visitors are repeat visitors from outside the state (van den Berg 2003, pers. comm.).

Length of trips in the Plan Area varied between a minimum of 3 to 4 days to a maximum of 3 weeks. The limited amount of recreation that occurs in the southern portion of the Plan Area (Ocean Point and southward) originates outside of the Plan Area and takes place mostly along the Colville River itself. For example, both Ocean Point and Nuiqsut are popular pull-out destinations for outfitter-guides operating from south of the Plan Area. Most of these guides use Umiat as the launching point. Even less recreation occurs in the northern portion of the Plan Area (north of Nuiqsut), and only one outfitter guide (Golden Plover Guiding Company) is actually based within the Plan Area.

It is difficult to accurately estimate the exact level of recreation that occurs within the entire Plan Area. On the basis of conversations with outfitter-guides, estimated summer recreation in the Plan Area is approximately 150 visitors per season.

RECREATION ACTIVITIES SEASONAL RECREATION

SUMMER ACTIVITIES

Summer recreation occurs mainly between the warmer months of June and August, with some guides operating into September (mostly for hunting purposes). Although conditions during the summer season can also be harsh, most notably because of the abundance of mosquitoes, June through August tend to be prime months for fishing and birdwatching. At least two outfitter-guides surveyed have traveled as far north as the Colville River Delta toward Harrison Bay, but such trips are much more expensive.

WINTER ACTIVITIES

Very little winter recreation is known to occur in the Plan Area beyond the immediate area of Nuiqsut. More distant travel is usually associated with subsistence hunting and fishing and with visiting other villages. The gentle terrain and wind-packed snow throughout much of the Plan Area create favorable snow conditions for snowmobile use, dog sledding, and possibly cross-country skiing. The best skiing is in the river and creek drainages where snow is deeper and the hard-packed surfaces are more level. The winds in the Arctic can be a serious deterrent to any recreational activity, particularly when wind blows loose snow that restricts visibility and creates severe wind-chill hazards. The most favorable months for winter recreation activities are April and May, when temperatures are usually higher and periods of daylight are longer (BLM 2003). Actual winter use estimates were not obtained, but use is presumed to be less than 50 participants during the winter season.

SPECIFIC RECREATION ACTIVITIES IN THE PLAN AREA

The most popular organized recreational activities in the Plan Area are described below, with most information provided from outfitter-guides contacted.

BIRDING

Birding is by far the most popular reason people visit the Plan Area, especially the areas along the Colville River. Of those outfitter-guides contacted who provide birding tours, all offer between one and two trips per season, with group sizes averaging between 4 and 10 participants. Outfitter-guides offering only one trip per season usually averaged slightly larger group sizes of between 6 and 10 participants. Most visitors participate in birdwatching while either backpacking or boating in the Plan Area (van den Berg 2003, pers. comm.).

Some of the most popular birding locations in the Plan Area include the bluffs along the Colville River (for peregrine falcons and gyrfalcons) and the Colville River Delta area. Although the Delta area is known for its birding potential, many visitors want to simultaneously experience the wilderness and opt for more remote birding locations such as the bluffs along the Colville River (van den Berg 2003, pers. comm.).

Among the most popular species of birds in the Plan Area are the raptors (including the rough-legged hawk and peregrine falcon) and other birds such as the bluethroat and arctic warbler. Outfitter-guides operating birding tours in the Colville River area consider it to be a world-class birding area, both because of its density of birds and because of the various species of birds found there. Although the potential for birdwatching within the Plan Area is considered high by local outfitter-guides, there is almost no promotion of the area for birdwatching, except by the outfitter-guides. On the basis of conversations with local outfitter-guides operating in the Plan Area, birding trip levels are estimated to be approximately 50 participants per season.

FLOAT TRIPS

Guided float trips along the Colville River area are among the most variable organized activities in the Plan Area because they usually include other activities. Outfitter-guides who offer float trips usually incorporate specific themes into their trips, including natural history, backpacking, birding, and photography. Trips last between 1 and 3 weeks, range from 2 to 10 participants, and usually include kayaks, canoes, and/or rafts. The majority of float trips begin south of Umiat and extend to or just north of Umiat, depending on the number of participants and the predetermined time frame of the trip.

Many outfitter-guides contacted offer only one float trip during the summer recreation season, with several offering at least two trips during a season. The total number of float trips in the Plan Area is difficult to estimate, in part because many visitors who come to the area partake in other recreational activities that are related to float trips. For example, many guides who offer bird tours use boats to access birding areas, as do guides who promote photography or backpacking. On the basis of conversations with outfitter-guides and including other related activities, the estimated participation in float trips in the Plan Area is approximately 50 people per season.

SPORT FISHING

Most sport fishing in the Plan Area occurs as part of other activities such as big game hunting and float trips. None of the outfitter-guides contacted gave sport fishing as a primary activity they lead or promote. Much of the fishing occurs during the ice-free summer months (BLM 2003), although the fishing season is open all year. No organized sport fishing occurs during the winter. The winter fishing that does occur is by residents of Nuiqsut and others who reside within the Plan Area.

Fish species sought by visitors include the arctic char, arctic grayling, lake trout, northern pike, whitefish, and various species of salmon (Andreis 2003, pers. comm.). Specific locations for sports fishing in the Plan Area depend mostly on the species of fish being sought. No specific use numbers for sport fishing are available for the Plan Area.

OTHER RECREATION ACTIVITIES

Other guided recreation in the Plan Area includes natural history tours, backpacking, fossil tours, photography, scenic overflights, and general scenic viewing. Most of these activities are combined with one or more activities in a typical trip. For example, backpacking and wildlife photography are often combined and offered for a guided tour, depending on the wildlife of interest. Most outfitter-guides offering these types of activities operate only one trip during the season, with group sizes ranging between four and eight participants and trips averaging between 5 days and 3 weeks. As with other guided activities, specific locations for such activities range from both south and north of Umiat, with very few outfitter-guides offering travel north of Nuiqsut.

Limited organized sport hunting occurs along the Colville River. Moose, caribou, and grizzly bears are the most sought-after big game animals. Aircraft are required to access most of if not all of the hunting areas along the Colville River, and boats are used to travel from location to location along the river. Overall, recreational hunters account for only a small fraction of big game animals harvested in the area. Hunting guides operating in the Plan Area average only one or two trips per season, with an average group size between two and six people.

The estimated participation in trips in the Colville River area for these various activities, based on conversations with outfitter guides, is approximately 40 people per season.

Wild and Scenic Rivers (WSR)

The Wild and Scenic Rivers Act (WSRA) (16 USC 1271-1287), PL 90-542, was approved on October 2, 1968. The act established the National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers could be identified and added to the system. The act authorized the Secretary of the Interior and the Secretary of Agriculture to plan areas and submit proposals to the president and Congress for addition to the system. Rivers are classified as wild, scenic, or recreational. Hunting and fishing are permitted in components of the system under applicable federal and state laws (USFWS, not dated).

A study completed in July 1972 by the Bureau of Outdoor Recreation (Alaska Task Force Report on Potential Wild and Scenic Rivers as part of the Native Claims Settlement Act) identified the Colville River (as well as the Ikpikpuk) as a WSR and recommended further review. The second WSR inventory was conducted in 1978 and again identified the Colville River as a candidate for WSR designation. The report (Section 105[c]) stated: "The Colville River from its headwaters to Umiat meets the criteria established by the WSRA for inclusion into the National WSR system as a wild river area. Outstanding values associated with the river area are: wildlife, geologic, recreational, and possible archeological."

Under provisions of the WSRA, Congress had a time frame of 3 years after submission of the latest study to address designation of the Colville as a WSR but failed to make any decision on the river's status. Because the 1978 study was found to be sufficient for congressional purposes, the Colville was placed under a protective management status. Protective management limits projects that would adversely affect the free-flowing nature of the river and provides for the enhancement of the outstanding values that made the river eligible for WSR status. Interim protection of the WSR values for the Colville River remained in effect until September 1984 (BLM 2003).

Although the physical characteristics and associated resource values make the Colville River eligible for designation, the river has been determined not "suitable" for WSR designation. This decision was based on the fact that other landowners within the potential WSR corridor did not support this action and, without their cooperation, management as a WSR would be ineffective (BLM 1998a). The current ASDP EIS is tiered to the Northeast National Petroleum Reserve-Alaska IAP/EIS, which considered WSR status for watersheds in the planning area. There is no new information regarding the river's "suitability" for inclusion as a WSR since the 1998 analysis was completed. In addition, the WSR status is outside of the scope of this specific development plan; therefore, it is not considered further in this EIS.

3.4.8 Visual Resources

3.4.8.1 Overview of Visual Resource Management (VRM) System

Visual resources are described below in the context of the Visual Resource Management (VRM) system. The VRM is the system used by the BLM to inventory visual resources. It also provides a way to analyze potential visual impacts and apply visual design techniques to ensure that surface-disturbing activities are in harmony with their surroundings. However, it should be noted that the Plan Area includes non-federal lands, that is, State of Alaska lands and Kuukpik Corporation lands. Neither of these entities has a system or methodology to assess the impacts of projects to the visual resources of the landscape. While the BLM cannot apply stipulations to non-federal lands, the VRM system will be applied to the entire project area. Implementing VRM involves two steps: conducting an inventory and providing an impact assessment. During the inventory stage, data are collected to identify the visual resources of an area and identify an inventory class.

VRM classes are used to define minimum management objectives. Each class describes the degree of modification allowed in the basic elements of the represented landscape type in question. The VRM system provides a way to identify and evaluate scenic values to determine the appropriate levels of management. The VRM recognizes the following classes.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.
- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer.
- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract the attention but should not dominate the view of the casual observer.

- Class IV Objective: To provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high and may dominate the view and be the major focus of viewer attention.

Inventory classes are informational in nature and provide the basis for considering visual values in the Resource Management Plan (RMP) process. The data used to develop visual classes include scenic quality, visual sensitivity, and distance zones. Scenic quality data needed to help establish VRM classes were collected as part of the 1979 105c report. A summary of these data is found in the project file, and distance zones are discussed in the context of impact assessment in Section 4 of this EIS.

VISUAL SENSITIVITY

Visual sensitivity is a key component in identifying VRM classes. In the 1979 105c report, visual sensitivity used two factors: the amount of use an area receives and viewers' expressed attitudes toward what they see. The report mapped areas of visual concern, delineating them as high, moderate, or low concerns for changes in scenic quality and for prevention of visible change in the landscape. Additional data used to determine sensitivity were obtained from meeting notes from subsistence advisory council meetings, written comments on the draft of the Northeast National Petroleum Reserve-Alaska IAP/EIS, and from conversations with agency staff knowledgeable about use within the study area. Areas identified as sensitive included known travel routes, areas of human habitation, areas of traditional use, and Native allotments. Relative to the ASDP, numerous areas were noted to have potentially high visual sensitivity.

3.4.8.2 Interim Visual Resource Management Classes in the ASDP Area

Classes in VRM were not established in the Northeast National Petroleum Reserve-Alaska IAP/EIS. It is BLM policy that interim VRM classes be established when a project is proposed for which no VRM objectives have been approved. Using scenic quality, sensitivity, and distance zones, as well as other management factors, the project area was assigned three VRM classes. The Colville River from the southern project boundary to Harrison Bay, including the Delta area, is VRM Class II. Fish Creek, Judy Creek, and the Ublutuoch River are VRM Class III. The rest of the project area is VRM Class IV (Figure 3.4.8.2-1).

Most of the project area falls within the scenic category identified as wet plains. This scenic unit is composed of flat plains near the coast, which includes thousands of small lakes, as well as small streams and rivers. The distinguishing features are its vastness and flatness. The landform is described as a flat continuous plain, displaying little relief other than a few stream corridors and pingos. Variation in elevation is approximately 2 meters. The casual observer sees little contrast in the vegetation because the tussock-forming species that compose the tundra are short and matted. A few larger plants (willow) are found along stream and river channels but are not evident enough to create interest. Notable contrast occurs between vegetated and nonvegetated areas along rivers and streams in the gravel bars and bluffs. The composition of the vegetation produces little variation in form, texture, and pattern. Water is the dominant visual element whether it be lakes, slow-moving streams, or meandering rivers. Colors provide contrast between the greens and browns of vegetation and barren soils and the blues and grays of the water bodies. Cultural modifications include manmade structures associated with Nuiqsut, isolated camps, and oil and gas facilities.

A small portion of the project area is described as coast offering broad and far horizons and big skies. Here the landform offers little physical relief. There is little contrast in vegetation, with the most contrast between vegetated and nonvegetated areas, and little variation in form, texture, and patterns. The Colville River Delta is the dominant element in this coastal landscape with numerous channels creating contrast between the water and land. Changes in color hue, value, and intensity are subtle. Again, the contrast is created between the vegetation, barren ground, and water bodies. Only a small part of the area has been modified by man. These cultural modifications include camps and oil and gas facilities.

3.4.8.3 Establishing Key Observation Points

During a four-day period in July 2003, BLM and ENTRIX staff visited many areas identified as sensitive and established 24 key observation points (KOPs) based on known travel routes and areas where people live. Locations of those KOPs are depicted on Figure 3.4.8.2-1. Six of these KOPs, considered representative of existing visual conditions in the Plan Area, are described in the following sections.

COLVILLE RIVER DELTA FACILITY GROUP KOPS

EXISTING CONDITIONS AT CD-1 AND CD-2

The total for CD-1 including an airstrip is 68.6 acres, while the total footprint for CD-2 including an access road is 24.6 acres. A boat launch pad associated with the Alpine Field is 0.1 acres. The total acreage permitted by USACE to be covered by gravel at CD-1 and CD-2 is 112.302 acres. CD-1 consists of numerous buildings (maintenance, storage, hazardous waste, worker dormitories), and the tallest buildings at CD-1 are approximately 75 feet tall, including 10-foot pillars. Several structures are found at CD-2, including wellhead houses, pig launcher/receiver building, a communications building, and a drill rig. At 205 feet in height, the drill rig is the tallest structure at CD-2. Drill rigs are temporary structures that are active (drilling) during different times of the year. For example, for the sites in the Colville Delta area, as displayed in Table 2.4.1-5, CD-3 will be drilled in the winter for several years, whereas CD-4 would be drilled in the summer. According to Table 2.4.1-5, CD-3 drilling could occur in the winter through 2011, and drilling at CD-4 could occur through the summer of 2009. CD-1 and CD-2 are connected by a 50-foot-wide gravel road that is 3 miles long. Additionally, CD-1 has an airstrip, which is 5,900 feet in length. Figures 3.4.8.3-1 and 3.4.8.3-2 show views of CD-1 and CD-2 from 5 and 15 miles south, respectively.

VIEWS LOOKING WEST-NORTHWEST, CONFLUENCE OF COLVILLE AND ITKILLIK RIVERS, KOP #3

This KOP is near the confluence of the Colville and Itkillik rivers close to water level, below the level of the surrounding terrain (N 70.13623°, W 150.98245° WGS84, as shown on Figure 3.4.8.3-3).

The site is representative of flat horizontal lines along the horizon with rounded curves and irregular lines along the gravel bars on the Colville River. Vegetation at the site is mainly woody shrubs such as willow. The vegetation is fairly dense and of uniform smooth texture on the uplands but has a scattered coarse texture on the gravel bars. The dominant landform color is a blend of grays and greens, with vegetation of various hues of green, while grays and browns/tans are visible in the barren ground of gravel bars and short bluff areas along the river, with blues and grays in the water.

VIEWS LOOKING NORTH FROM VILLAGE OF NUIQSUT, KOP #12

Nuiqsut is approximately 8 miles southeast of CD-1 and 9 miles from CD-2, which are both in the background zone. The population of this community is approximately 450 people. Meeting notes from recent scoping efforts indicate the area around Nuiqsut is of high visual value to residents of this community. KOP #12 is on the north side of the village of Nuiqsut (N 70.23092°, W 151.01349° WGS84, as shown on Figure 3.4.8.3-4).

Cultural modifications visible from this KOP include the community of Nuiqsut, the landfill, and associated access roads, all in the foreground-middleground zone. CD-1 and CD-2 are observable to the north in the background zone. A pipeline is visible running north to south within the foreground zone. There is a strong contrast between the horizontal lines of the natural environment shown in the northward view of Figure 3.4.8.3-4 and the vertical lines seen from other perspectives of buildings and other structures associated with the community, CD-1, and the CD-2 drillrig. Color contrast is introduced through the gravel road, pipelines, culverts, and other structures that have different colors than the various hues of green associated with the vegetation. Some contrast in texture occurs in the immediate foreground between smooth structures and the coarse vegetation. The community profile introduces a coarse texture in contrast to the smooth texture of the vegetation.

VIEWS LOOKING SOUTH FROM NIGLIQ CHANNEL, KOP #20

KOP #20 is near the Nigliq Channel (N 70.31232°, W 151.03888° WGS84, Figure 3.4.8.3-5). This KOP represents views from water level and not from the uplands. The landform of this KOP is a wide and flat river channel with low horizons. The uplands rise less than 2 m above the river level. The predominant color of the foreground-middleground zone is brown and gray from the river rocks and silt along the Nigliq Channel. The vegetation presents a variety of hues of green. The background and seldom seen zones present as smooth and flat. However, the foreground-middleground zones transition from irregular coarse to regular smooth as distance increases and the shapes of vegetation become blurred. The river channel presents grays and blues of the water with irregular curved lines while the gravel bars and river banks have various shades of browns and grays.

Several permanent structures were visible from KOP #20. These cultural modifications include CD-2, the CD-1 (4 miles), and pipelines. The buildings, pipeline supports, and drill rig introduce regular horizontal and vertical lines into a predominantly irregular horizontal landscape in the background zone. The existing facilities, with white, blue-green, and orange buildings, create an overall strong contrast with the natural colors of their surroundings.

VIEWS LOOKING NORTHEAST FROM NIGLIQ CHANNEL, KOP #21

KOP #21 is near the Nigliq Channel in view of cabins on the west side of the channel (N 70.39138°, W 151.08667° WGS84, Figure 3.4.8.3-6). This KOP is along the uplands above river level.

The landform of KOP #21 is flat, open tundra near the Bering Sea (Harrison Bay), which presents as low horizontal lines. The foreground-middleground has curved and some irregular lines because of water bodies. The predominant color of the foreground-middleground is various shades of green with uneven, random browns associated with unvegetated areas. The water adds blues and grays, while the river channel adds browns and tans from rocks and silt. The foreground-middleground vegetation has a medium texture and is uneven and random because of the types of vegetation growing on the tundra, giving a mottled appearance. The background, seldom-seen zones have a smooth texture. Several cultural modifications were visible from KOP #21. These included cabins on the west side of the Nigliq Channel and CD-2 to the northeast (4 miles) and CD-1, also to the northeast (5 miles). These structures introduce vertical lines into a predominately horizontal landscape. Contrast is also present in the whites and orange colors of the structures.

VIEWS LOOKING WEST FROM NORTHWEST FROM A POINT WEST OF THE LOWER NIGLIQ CHANNEL, KOP #18

KOP #18 is near a cabin (N 70.31593°, W 151.35501° WGS84, Figure 3.4.8.3-7). This KOP is near water level, slightly lower than the surrounding terrain. One permanent structure, a cabin, is visible from KOP #18. The vertical lines of the structure contrast with the horizontal lines associated with the natural surrounding vegetation and water. The structure is visible in the foreground-middleground zone and could attract the attention of a casual observer. The landform is very flat, with brown sand and blue to gray water bodies. In general, the landform texture is rough as a result of the barren ground visible alongside the creek. The remaining landform is covered with two-toned vegetation that is light and dark green in color. The vegetation is a grass and woody shrub mixture that is rough and patchy rather than evenly distributed and smooth in texture.

FISH-JUDY CREEKS FACILITY GROUP KOPS

VIEWS LOOKING WEST FROM NEAR THE CONFLUENCE OF FISH AND JUDY CREEKS, KOP #14

KOP #14 is near the confluence of Fish and Judy creeks (N70.24977°, W 151.90631° WGS84, Figure 3.4.8.3-8). This KOP is situated above the river plain on the uplands, resulting in a view of both the immediate river valley and extended views of the coastal plain. The landform is mostly flat and low with simple horizontal lines in the foreground. Irregular line contrast is created between the vegetated and nonvegetated areas in the foreground. Exposed bluffs along the creek create a contrast between the vegetation and barren ground in color and texture. The line form of the bluffs is irregular diagonal. Continuous stretches of sandbars and beaches are observable in the foreground, creating smooth rounded lines in contrast to the flat horizontal lines of the horizon. Vegetation creates an irregular texture in the foreground transitioning to smooth fine textures in the background. No permanent structures are present.

KALIKPIK-KOGRU RIVERS FACILITY GROUP KOPS

No KOPs were established for the Kalikpik-Kogru Rivers Facility Group.

3.4.9 Transportation

Alaska’s transportation system consists of roadways, railroads, air facilities, and marine facilities. Because of the large size, small population, and extreme climatic conditions of the state, marine and air transportation play a large role in the transport of materials and people throughout the state and particularly to facilities on the North Slope. In addition to these transportation systems, oil and gas products are transported throughout the North Slope and from the North Slope to market through a series of pipelines. Transportation facilities associated with activities in the Plan Area are discussed in the following sections (Figure 3.4.9.1-1).

Although the Federal Highway Administration (FHWA) and the FAA control construction of public roads and airports, these agencies do not typically regulate traffic levels on facilities once those facilities are constructed. There are no regulatory programs that control construction or use of private transportation facilities, although land management agencies, such as the state and the BLM can limit construction and use of transportation facilities on their lands through permit or lease conditions.

3.4.9.1 Road Systems

STATE ROADS

The Dalton Highway provides road access to the North Slope. This 415-mile gravel highway from Livengood to Deadhorse was constructed to support oil development on the North Slope and was originally limited to authorized commercial traffic beyond the Yukon River Bridge (Figure 3.4.9.1-1). Since 1994, the entire Dalton Highway has been open to the public. Traffic on the road now consists of a mixture of commercial trucks, private vehicles, and commercial tour operators. Commercial trucks still composed almost 40 percent of the vehicle traffic on the Dalton Highway in 2000 (ADOT&PF 2003a). In 2002, 549 loads of freight totaling approximately 14 million pounds arrived by road to the North Slope for operations at the Alpine Field (CPAI 2003b). Noncommercial traffic occurs primarily during the summer and on the southern portion of the highway. Recent traffic levels reported by the Alaska Department of Transportation and Public Facilities (ADOT&PF) are listed in Table 3.4.9-1

TABLE 3.4.9-1 ADOT&PF HISTORIC TRAFFIC LEVELS FOR THE DALTON HIGHWAY

	Annual Average Daily Traffic (vehicles)								
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Yukon River Checkpoint	291	385	398	490	388	410	266	266	223
Bonanza River Checkpoint	211	220	320	302	293	240	283	283	NA[a]
Dietrich River Checkpoint	205	210	185	254	232	172	207	207	254
Kuparuk Checkpoint	174	205	182	301	240	191	230	230	274

Source: ADOT&PF 2003a
Note:
[a] Bridge under construction; numbers not available
NA = not available

The Dalton Highway is typically 28 feet wide; however, the ADOT&PF is in the process of upgrading the highway to a uniform width of 32 feet. The road is also being resurfaced with a high-float emulsion to improve road quality and reduce vehicle fugitive dust emissions. The ADOT&PF expects 90 to 95 percent of the highway to be resurfaced by the end of 2006 (ADOT&PF 2001b, in TAPS EIS).

Although the Dalton Highway is currently the only state road providing access to the North Slope, the ADOT&PF is currently evaluating the potential to construct additional roads in this area. In particular, the Colville River Road has been identified as one of the ADOT&PF's top priorities for road construction (ADOT&PF 2003b, 2003c). The proposed 18-mile road would start at the southwestern end of the existing Spine Road and would extend west to a proposed Colville River bridge site. The proposed bridge site is located 3 miles south of Nuiqsut and approximately 11 miles upstream from the Alpine Field. The Colville River Road would continue another 2.3 miles after crossing the proposed Colville River bridge, to connect to a BIA-proposed road to Nuqusit. The State of Alaska has also indicated a desire to construct additional roads in the National Petroleum Reserve-Alaska. Access on these roads could be limited to oil industry traffic and residents of Nuiqsut (ADOT&PF 2003b).

OIL INDUSTRY ROADS

The oil industry has developed an extensive network of access roads to facilities on the North Slope. Almost 350 miles of roads have been developed to serve existing production fields on the North Slope (BLM 1998a). These roads are restricted to authorized traffic, which includes some use by local residents. The main road within the Prudhoe Bay and Kuparuk operations area is the Spine Road. This gravel road provides access from the Dalton Highway at Deadhorse to oil facilities from Endicott in the east to Kuparuk in the west. Most oil facilities on the North Slope are connected to Spine Road by gravel roadways that are typically 30 to 35 feet wide and approximately 5 feet in elevation.

The existing Alpine Field, in the Colville River Delta west of concentrated oil industry development in the Prudhoe Bay and Kuparuk areas, provides an exception to the typical infrastructure for oilfield access. Although the Alpine Field has a road connecting the two production facilities, there is no all-season road that connects the Alpine Field with oil industry infrastructure to the east. Access to the Alpine Field occurs by air or by ice road or low ground pressure vehicle in the winter.

ICE ROADS

Alaska Natives have historically used frozen rivers and other waters as ice roads for winter travel and for transporting supplies, such as fuel. Winter ice roads now provide access to oil industry roads and the Dalton

Highway for Nuiqsut residents. Oilfield development on the North Slope has also relied on ice roads to provide access for facility construction.

WINTER VEHICLE AND LOW GROUND PRESSURE VEHICLE TRAVEL

In addition to the use of ice roads, winter overland access on the North Slope also occurs by low ground pressure vehicles. These vehicles are used to transport goods and materials over land during the winter and after July 15 on state lands.

3.4.9.2 Aviation Systems

AVIATION FACILITIES

Air transportation is critical in Alaska because of the distances involved and the limited road access available. Air transportation provides year-round access to remote communities and oil industry facilities for goods and people. It also provides cargo transport. The primary state international airports are in Anchorage, Fairbanks, and Juneau. Alaska also has an extensive network of state owned and operated rural airports, including the airports at Deadhorse and Barrow. Nuiqsut has a public airport owned and operated by the NSB. In addition, the oil industry has developed private airstrips to support facilities. Dozens of airstrips, both paved and unpaved, exist within the National Petroleum Reserve-Alaska and the Plan Area (Figure 3.4.9.1-1).

STATE AIRPORTS

The state owned and operated Deadhorse Airport has an asphalt runway (Rwy 04/22) that is 6,500 feet long and 150 feet wide (FAA 2003a). FAA records indicate that five aircraft and two helicopters are based at the airport, although the number of aircraft operating out of this airport changes by season depending upon oil industry activity levels (FAA 2003a). This airport serves an essential role in moving goods and people from Alaska and the Lower 48 states to the North Slope. The latest annual operations estimate for Deadhorse was 19,600 operations (takeoffs or landings), with almost half of these operations being general aviation, rather than air carrier, commuter, or air taxi operations (FAA 2003a). Alaska Airlines provides scheduled public air carrier operations into Deadhorse; other operations are chartered and primarily related to transporting oil industry personnel and goods (Alaska Airlines 2003, Deadhorse Airport 2003c). The oil industry's Shared Services Aviation organization provides at least two Boeing 737 jet flights to Deadhorse every weekday and one on Sunday. In addition, Shared Services Aviation provides jet service from Deadhorse Airport to Kuparuk, as well as multiple weekday and Sunday flights from Deadhorse to the Alpine Field, Badami, and Kuparuk by Twin Otter or CASA plane.

The state also owns and operates the Wiley Post-Will Rogers Memorial Airport in Barrow. The runway at Barrow is 6,500 feet long and 150 wide and is surfaced with asphalt (FAA 2003b). A total of 16 aircraft and 3 helicopters are reportedly based at this airport. Annual operations are estimated at 11,750, of which 1,200 are air carrier operations, 2,000 are commuter aircraft operations, and 4,000 are air taxi operations. The remaining operations are general aviation, except for 50 operations listed as military. Alaska Airlines provides scheduled passenger operations into Barrow with two flights per day.

OTHER PUBLIC AIRPORTS

The NSB owns and operates the Nuiqsut Airport, which has a 4,343-foot gravel runway that is 90 feet wide (FAA 2003c). No aircraft are based at this airport. The Nuiqsut Airport has annual operations of 1,500 flights, of which 1,200 are classified as air taxi operations. There are no scheduled air carrier operations at the airport, although there are scheduled air taxi and commuter operations, chartered passenger and cargo operations, and private general aviation.

OIL INDUSTRY AIRPORTS

The oil companies operating on the North Slope operate and maintain one primary airstrip at Kuparuk. This airstrip is approximately 6,500 feet long and 150 feet wide. Additional airstrips are located at the Badami and Alpine Field production sites. Shared Services Aviation provides air transportation services to CPAI, BPXA, and Alyeska Pipeline Service Company. Shared Services Aviation operates Boeing 737 jet aircraft to transport personnel to and from the North Slope. Shared Services Aviation also operates a Twin Otter and a CASA 212 to transport personnel to various operations sites within the North Slope area. In addition, the oil industry charters Twin Otter and Convair aircraft for flights along the TAPS and uses charter helicopter support as required.

Shared Services Aviation provides up to five daily jet flights to and from the North Slope, as well as multiple daily flights between various North Slope operations sites. For example, an estimated two to six daily Twin Otter flights and one to three daily CASA flights are currently scheduled into the Alpine Field (CPAI 2003a). These flight schedules are subject to change depending on passenger demands at the various sites.

3.4.9.3 Marine Transportation

Marine transportation is vitally important to the oil industry because of the cost-effectiveness of transporting heavy equipment and cargo with a low value-to-weight ratio by barge. Alaska’s major ports are in Anchorage, Seward, Valdez, and Whittier, and much of the cargo shipped to the North Slope passes through these ports. Some cargo is transferred from barge to railroad at the ports; other cargo continues by barge to the North Slope.

There is no deepwater port on the North Slope; facilities are limited to shallow-draft docks with causeway-road connections to facilities at Prudhoe Bay and beach landing areas at some local communities. Freight is typically offloaded from cargo ships and barges to shallow-draft ships for lightering to shore. Smaller craft are sometimes used to transport cargo upriver to communities that are not situated on the coast, such as Nuiqsut. Ice conditions in the Beaufort Sea limit marine shipments to the North Slope to a very short period from late July through early September.

Five docks are located within the oil industry facilities on the North Slope: East Dock, two at West Dock, one at Badami, and one at Oliktok Point (Figure 3.4.9.1-1). The East Dock facility at Prudhoe Bay is no longer in operation. West Dock at Prudhoe Bay is a 13,100-foot-long by 40-foot-wide, solid fill, gravel causeway, along the northwest shore of Prudhoe Bay east of Point McIntyre. The causeway has breeches required for fish passage, and bridges span the breeches. Transportation of vary large equipment (such as drill rigs) over these bridges is limited due to width and weight restrictions. Heavier equipment delivered to West Dock can be staged there until winter when the equipment can be transported by ice roads to the desired location. Water depths around the causeway average 8 to 10 feet (BLM 1998a). West Dock has two unloading facilities, one 4,500 feet from shore with a draft of 4 to 6 feet and another 8,000 feet from shore with a draft of 8 to 10 feet. Badami’s solid fill gravel dock is 1,000 feet long and has a maximum water depth of 6.4 feet. Use of the dock is limited to light barges and small craft. The dock at Oliktok Point extends 750 feet from shore and has a draft of 5 feet at the bottom of the dock boat ramp and a draft as deep as 10 feet at the dock face (BLM 1998a).

Primarily, the oil industry uses marine transportation to transport oversize equipment, such as large drilling modules, during exploration and construction of operations facilities. Marine transportation is rarely used for supplies during normal operations of individual fields, such as the Alpine Field (CPAI 2003a).

3.4.9.4 River Transportation

Multiple waterways in the Colville River Delta are used for transportation inland from coastal areas. The most commonly used waterways in the plan area include the Ublutuoch River and the Nigliq, Sakoonang, Tamayayak, and Ulamnigiaq channels. As shown on Figure 2.4.1.1-1, the later three channels are in the delta between CD-1 and CD-3. Both the oil industry and local residents use boats on these waterways.

Industry boat usage in the area is limited to spill response training by Alaska Clean Seas. This oil spill response cooperative, whose membership includes oil and pipeline companies, is responsible for providing personnel, material, equipment, and training response capability for responding to and cleaning up an oil spill on the North Slope. Due to existing operation of oil production facilities at CD-1 and CD-2, as well as the Alpine Pipeline that crosses under the Colville River, Alaska Clean Seas must train in nearby waterways. Navigation through the Sakoonang, Tamayayak, and Ulamnigiaq channels is achieved using various vessels including a twin-engine freighter, single-engine airboats, Athebasan outboard jet boats, and Klamath outboard jet boats (CPAI 2004).

Alaska Clean Seas performs navigation training for spill response teams with the vessels several times during open water. Personnel travel the northern channels in the spring to check remote connexs containing spill response equipment and to place navigational buoys around the entrance areas to each channel. Absorbent boom is deployed in the spring and removed each fall. Permits issued by the ADF&G generally limit air boat traffic to a two-week window in the spring and then several week in the fall to mitigate impacts to waterfowl (CPAI 2004). Mid-summer training on the northern channels is limited to jet boats.

The largest vessel that would be used by Alaska Clean Sea in the Nigliq Channel is the Agviq, measuring 55 feet long and 12 feet wide. This landing craft is used for equipment transport and skimming operations. The Agviq’s 26-foot mast height would require that the mast be removed for the vessel to fit under a 20-foot bridge (CPAI 2004). However, it is likely that smaller boats would be used in the northern channels rather than the Agviq. The Agviq is the only Alaska Clean Seas vessel that would require any modifications to pass beneath a 20-foot bridge.

The village of Nuiqsut lies approximately 18 miles upriver of the Beaufort Sea on the Nigliq Channel of the Colville River. Villagers use small watercraft for transportation along the rivers and channels to access hunting and fishing areas and to travel to marine areas for whaling and marine hunting. Some boats have shelters, which bring the height of the boats to about 10 feet above the water level. Some residents’ flat-bottom and V-bottom boats have aerials that go up to about 20 feet above the water level; however, they are easily retractable and do not inhibit travel under a 20-foot bridge (Tukle et al., 2004). Village boats typically travel on the Nigliq Channel and Ublutuoch River, as well as on the Tamayayak and Ulamnigiaq channels from Nuiqsut to areas past the proposed location of CD-3 (Nukapigak 2004). Boats cannot typically navigate the Sakoonang Channel (Nukapigak 2004).

3.4.9.5 Pipeline Systems

Oil produced on the North Slope is transported to Valdez through the TAPS. This system includes 800 miles of 48-inch-diameter crude oil pipeline, as well as pump stations, communications sites, and other support facilities. The pipeline delivers oil to the marine terminal at Valdez where it is transferred to oil tankers for delivery to final markets. The TAPS was designed to allow a maximum throughput of 2.2 MMbbl a day and averaged 2 MMbbl a day at peak oil production in 1988. Production more recently has dropped to just under 1 MMbbl a day (Alyeska Pipeline Service Company 2003).

Oil is transported from various oil production facilities on the North Slope to Pump Station 1 of the TAPS through various pipelines. Seven major trunk pipeline systems carry crude oil to the TAPS, and numerous production pad feeder pipelines carry oil from production facilities to these trunk lines. Crude and noncrude pipelines serving existing North Slope production facilities include approximately 415 miles of pipeline corridor (with some corridors including multiple pipelines bundled together) and are elevated above ground on VSMs (BLM 1998a). Access roads have been constructed adjacent to the pipelines to allow for inspections, maintenance, and repairs.

Oil produced from the existing Alpine Field is transported to the main sales oil pipeline through a 35-mile-long pipeline that is 14 inches in diameter. The pipeline is primarily located above ground, except where it crosses the Colville River and oilfield roads. This pipeline from the APF at CD-1 currently carries 100,000 barrels of oil a day to Kuparuk and then on to TAPS Pump Station 1. There is also a three-phase line going from CD-2 to CD-1 that carries produced fluids (oil, gas, and water) to CD-1 for processing (removing gas and water).

3.4.9.6 Alaska Railroad Corporation

The Alaska Railroad provides freight service between ports at Anchorage, Seward, and Whittier and to Fairbanks. The railroad serves an important role in transporting incoming freight, particularly during periods when barges cannot reach the North Slope. Cargo from barges can be off-loaded at these ports and transported by rail to Fairbanks, where freight for the North Slope can be off-loaded onto commercial trucks for delivery. Rail shipments of Oil Country Tubular Goods (or drilling pipe) ranged from 21 to 67 railcar loads over the past 4 years (CPAI 2004). These goods were offloaded from the Alaska Railroad in Fairbanks for ground shipment to the Alpine Field. Although rail transport plays a minor role in overall transportation of materials to the North Slope, it is an economical means of shipping large, heavy goods and is used for these goods on a regular basis.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

SECTION 4
ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This section provides an analysis of potential impacts to the natural and human environment that could result from implementation of the proposed action and alternatives and FFD alternatives. The analysis is based upon consideration of existing conditions in the affected environment and potential effects of construction, operation, and abandonment of project components such as roads, bridges, production pads, processing facilities, airstrips, pipelines, and power lines. The comparison of the impacts by alternative is located in Table 2.7-1. Included in the table is a comparison of impacts from spills for each resource, by alternative. Potential mitigation measures that could be used to avoid or reduce impacts are also introduced and described.

Portions of the analysis have required development of predictive models to simulate potential impacts. The assumptions, guidelines, and methods used to conduct such analysis are stated to provide the reader with a basis for understanding and judging the reliability of the analysis. Other parts of the analysis have been conducted through consideration of government regulatory standards, available scientific documentation, and the professional judgment of resource specialists.

4.1.1 ORGANIZATION OF IMPACT ANALYSIS

SECTION 4.2

Section 4.2 introduces existing and potential additional mitigation measures that may be applicable to portions of the proposed action and alternatives and FFD alternatives through lease stipulations or applicability of the ROD for the Northeast National Petroleum Reserve-Alaska IAP/EIS.

SECTION 4.3

Section 4.3 presents an analysis of the probability and potential impacts of oil and salt water spills. Although spills are not a part of the proposed action or alternatives and FFD alternatives for the Plan Area, they could occur as a result of the proposed action and alternatives and result in impacts to the environment.

SECTIONS 4A, 4B, 4C, AND 4D

Sections 4A, 4B, 4C, and 4D present the impact analysis for Alternative A, Alternative B, Alternative C, and Alternative D, respectively. Each of these sections first presents an analysis of the CPAI Development Plan alternative, followed by analysis of the FFD alternative that is based upon the same theme. For the purpose of analysis, production pads and processing facilities associated with FFD alternatives have been organized into three facility groups:

Colville River Delta Facility Group

HP-4, HP-5, HP-7, HP-8, HP-12, HP-13, HP-14

Fish-Judy Creeks Facility Group

HP-1, HP-2, HP-3, HP-6, HP-9, HP-10, HP-11, HP-15, HP-16, HP-17, HP-19, HPF-1

Kalikpik-Kogru Rivers Facility Group

HP-18, HP-20, HP-21, HP-22, HPF-2

SECTION 4E

Section 4E presents an analysis of the No-Action Alternative. Under this alternative, the proposed action (Alternative A) or Alternatives B, C, or D would not be authorized and would therefore not be constructed or operated.

SECTION 4F

Section 4F presents an analysis of the agency preferred alternative. This alternative includes components common to other alternatives and new components designed to further mitigate impacts.

SECTION 4G

Section 4G presents an analysis of cumulative impacts. By definition, cumulative impacts are impacts that would result from the proposed action or alternatives in combination with other past, present, and reasonably foreseeable actions in the affected environment.

SECTION 4H

Section 4H presents a disclosure of other impact considerations, including unavoidable adverse impacts; relationship between local short-term uses and maintenance and enhancement of long-term productivity; and irreversible and irretrievable commitment of resources.

4.2 EXISTING AND POTENTIAL ADDITIONAL MITIGATION MEASURES

Any oil development in the ASDP Area would incorporate design and operation measures that would protect the environment. These measures would reflect the applicant’s proposal, applicable federal, state, and NSB laws and regulations, and requirements of the leases that the applicant plans to develop. In addition, the federal RODs issued following completion of this EIS, the State of Alaska Coastal Consistency Review, and any federal, state, and borough permits necessary to authorize development could impose additional mitigation measures.

In its proposal, CPAI includes several measures to protect the environment. The most significant are provisions for pipeline valves on either side of larger river channels to minimize spill size in the event of a leak or break, placement of gravel roads downhill from the pipeline to aid in control of potential pipeline leaks, and installation of bridges rather than culverts across major waterways to ensure fish passage and minimize changes to riparian habitat. Additionally, CPAI proposes to minimize the size of gravel pads at production sites to reduce the project footprint, places a heavy reliance on winter construction and ice road use to minimize tundra damage, proposes a winter-only drilling plan for the lower Colville River Delta production pad to minimize impacts to nesting or molting bird populations, and maintains and enforces company rules against employees hunting, fishing, or disturbing wildlife.

Federal, state, and NSB laws and regulations also mitigate impacts. Many laws and regulations mandate certain protections for the environment. For example, regulations pursuant to the federal Clean Water Act establish limits for the discharge of pollutants. Regulations promulgated to enforce the National Historic Preservation Act and its Alaska counterpart mandate cultural resource surveys and avoidance measures to protect important archaeological and historic resources. State law and regulations prohibit habitat degradation in anadromous waters. The NSB requires that pipelines be no less than 5 feet above the tundra. (See Table 1.1.4-1 and Appendix C for a more complete list of authorities that provide environmental protection.)

In addition, the applicant is bound by the conditions of the leases purchased. Federal lease stipulations are listed in Appendix D. These include a wide variety of provisions, such as restrictions on oil development activities in certain areas and at certain times. Stipulated state mitigation measures vary by lease, but generally include restrictions on development during snow-free seasons, restrictions on development near or in critical habitat or use areas, and requirements for agency review and approval of development and operation plans.

The following analysis of impacts assumes the protections provided by the applicant's design; by federal, state, and NSB law and regulation; and by lease stipulations. Impacts identified under each alternative could occur despite these protections. In order to further mitigate impacts, this section also identifies potential additional mitigation measures. These mitigation measures are identified under each alternative following the discussion of potential impacts for each resource or use. The BLM ROD will identify which mitigation measures the BLM will adopt. Cooperating agencies could adopt mitigation measures as part of their RODs.

Unless granted an exception or a modification of the Northeast National Petroleum Reserve-Alaska IAP/EIS as part of this EIS, activities on BLM-managed lands must be conducted and facilities sited in accordance with the ROD for the Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations (Appendix D). These stipulations were developed to minimize environmental impacts that could result from oil and gas development activities on federal lands within the Northeast National Petroleum Reserve-Alaska. Measures presented in the Northeast National Petroleum Reserve-Alaska stipulations are actions that could also minimize impacts to the environment on state and private lands included in the ASDP Area and could be applied by the cooperating agencies to the proposed action and alternatives and FFD alternatives as mitigation measures. The Northeast National Petroleum Reserve-Alaska stipulations that would also mitigate impacts on state and private lands are hereby incorporated by reference into the mitigation sections of the EIS.

4.3 IMPACTS OF OIL, SALT WATER, AND HAZARDOUS MATERIAL SPILLS

4.3.1 SUMMARY

In summary, this section describes the rate, behavior, and potential impacts of spills in a variety of spill scenarios. Spills[1] are not a planned activity for any alternative. Spills are generally unpredictable in cause, location, time, size, duration, and/or material type (Mach et al. 2000). With few exceptions, the occurrence of spills is not dependent upon the alternative chosen, except that the No-Action Alternative (Alternative E) would not result in spills from the ASDP in the Plan area.

Spills of produced fluids, crude or refined oil, salt water, and other chemicals from the proposed five-satellite CPAI Development Plan or from the FFD have a finite rate of occurrence; might affect the environment to varying degrees; and are of concern to all of the stakeholders. The spill scenarios used in this EIS, especially for the larger volume spills, are likely to overestimate, in some cases substantially, the rate or probability of a spill and/or the potential impacts.

For this EIS, the materials that could be spilled are categorized and described as follows:

- Produced Fluids – composed of crude oil, natural gas, brine[2,] and formation sand.
- Crude (=Sales) Oil – oil separated from the brine, natural gas, formation sand, and other impurities and then transported to the Trans-Alaska Pipeline and eventually to the Valdez Marine Terminal.
- Refined Oil – Arctic diesel, Jet-A 50 (which is very similar to diesel), unleaded gasoline, hydraulic fluid, transmission oil, lubricating oil and grease, waste oil, mineral oil, and other products.

---

[1] Spills, in various documents, are sometimes referred to as releases, blowouts, uncontrolled releases, leaks, or accidental spills. This EIS uses spills to include all of these terms, as well as any spill that results from sabotage, vandalism, and any other unauthorized release during construction, drilling, production, abandonment, and restoration/rehabilitation of the CPAI Development Plan and FFD.

[2] In this EIS, "brine" refers to the saline water that is part of the produced fluids (in addition to crude oil, natural gas, and formation sand) coming from the oilfields. Brine is commonly also called produced water.

- Salt Water [3]– composed of treated seawater from the Kuparuk Seawater Treatment Plant (STP) at Oliktok Point and brine separated from the produced fluids.
- Seawater – treated seawater from the Kuparuk STP at Oliktok Point.
- Other Hazardous Materials – includes methanol, antifreeze, water soluble chemicals, corrosion inhibitor, scale inhibitor, drag reducing agent, and biocides.

The ADEC Spill Database (Section 4.3.2) also includes spills of Halon, drilling muds, gravel, fresh water, bentonite, and natural gas. Halon is a gas and its use on the North Slope has been discontinued. Natural gas is also a gas that dissipates rapidly in the atmosphere and has little to no impact on the natural resources. Fresh water is a major constituent of the normal habitat and has little to no environmental impact. Gravel spills occur on or adjacent to roads and pads; they are at most a small areal extension of the impacts described for these structures in Section 4A.3.1 through Section 4F.3.1. Drilling muds, including bentonite, are primarily clay and water and most releases are on or adjacent to roads or drilling pads. Like gravel, the impacts are a small areal extension of the impacts described for these structures in Sections 4.3.2.4 Sewage spills are not included in this discussion (Section 4A.2.2.2 through Section 4F.2.2.2) for more information on sewage spills) because they are not considered oil, salt water, or hazardous material; they are not included in the ADEC database (ADEC 2003d); and they are typically small and confined to pads.

The rate, risk, probability, and impacts of oil and hazardous material spills on the North Slope have received extensive analysis and review in several recent EISs, environmental assessments, and other reports. Although the details differ among several of the documents, the basic data and conclusions are generally similar. This EIS incorporates these documents by reference and summarizes the key points. Referenced documents include the following:

- Northwest National Petroleum Reserve-Alaska Draft Integrated Activity Plan/Environmental Impact Statement (BLM and MMS 2003)
- Northeast National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement (BLM and MMS 1998a)
- Alaska Outer Continental Shelf, Liberty Development and Production Plan, FEIS (MMS 2002)
- Final Environmental Impact Statement, Beaufort Sea Oil and Gas Development/Northstar Project (USACE Alaska District 1999)
- Final Environmental Impact Statement: Renewal of the Federal Grant for the Trans-Alaska Pipeline Right-of-Way (BLM 2002a)
- Environmental Report for Trans-Alaska Pipeline System Right-of-Way Renewal (TAPS Owners. 2001a)
- Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003)
- A review of Oil Spill Risk Estimates Based on Current Offshore Development Technologies. NSB-SAC-OR-130 (NSB 2003b)
- Environmental Evaluation Document, Colville River Unit- Satellite Development, Revised June 2002 (CPAI 2002)
- Oil Discharge Prevention and Contingency Plan (ODPCP) April (CPAI 2003)
- Estimation of Oil Spill Risk from Alaska North Slope, Trans-Alaska Pipeline, and Arctic Canada Oil Spill Data Sets (Mach et al, 2000)

---

[3] For this EIS, salt water is used as a general term to include seawater [described below] unless there is a specific reference to the seawater alone

This section identifies the primary causes and sources of spills and refers back to Section 2 for the construction, drilling, operation, maintenance, abandonment and restoration/rehabilitation procedures, facility design, and CPAI training programs that are designed to mitigate these causes. Section 2 is also referenced for the response plans required by state, federal, and borough agencies and detailed by CPAI in their ODPCP (CPAI 2003f). However, accidental spills will still occur. This section also describes the rate, characteristics, and impacts of those potential spills.

Where appropriate, this EIS considers the impacts of spills that occur during construction[4], drilling, and production/operations activities separately. However, in the first few years of the CPAI Development Plan and longer in the FFD, all of these activities will be occurring simultaneously, usually, but not always, in separate locations. The majority of construction spills tend to be relatively small, and most result from vehicle and construction equipment fueling and maintenance (NRC 2003, Mach et al. 2000). A tanker truck accident or a fuel storage tank failure is the most likely source of the largest construction spills. Spills from pipelines, well blowouts[5], uncontrolled releases, or facility accidents would not occur at a construction site. These latter spills could occur during drilling and production operation phases due to a variety of causes including structural failures and have the potential to result in larger-volume spills.

Spills could occur on and/or from pipelines, production pads (and FFD APFs), airstrips, roads, and bridges. Spills that leave the gravel pads and gravel roadbed could reach one or more of several habitat types including wet and/or dry tundra, tundra ponds and lakes, flowing creeks and rivers, Harrison Bay[6], and potentially the adjacent nearshore Beaufort Sea. Spills could occur anytime in the year. For this impact assessment, the year is divided into four “seasons”: (1) summer ice-free, (1) fall freeze-up, (3) winter ice cover, and (4) spring break-up. In addition, high water events will occur in spring and may occur in fall, depending upon weather conditions, which could also influence the environmental impact of a spill. Also, high wind events could result in higher or lower than normal water levels and/or could affect the areal extent of impact from a high pressure release from a pipeline that sprays into the air.

Spill impact assessment considers what happens when the probability of a spill has reached 1.0; that is, the spill has occurred. Spill impact assessment is subject to numerous uncertainties and unknowns. As in most of the references consulted for this assessment (including those incorporated by previous reference), the following impact assessment is based on prior analyses for the North Slope, collective empirical experience of spill personnel with North Slope spills, other published and technical reports, experience elsewhere, and the professional judgment of a wide variety of experts (including the author of this EIS section) experienced with oil, chemical, and salt water spills.

The rate of oil and salt water spills from the CPAI Development Plan and FFD is likely to be lower than the history of the past 30 years of oil exploration, development, production, and transportation on the North Slope. The combination of more stringent agency regulations, continually improving industry operating practices, and advancements in Best Available Control Technology (BACT) all serve to reduce the probability and size of spills. The 30-year North Slope history shows that the vast majority of the oil, produced fluids, salt water, and other material spills that have occurred have been very small (fewer than 10 gallons) and very few have been greater than 100,000 gallons (NRC 2003, Mach et al. 2000). The history also shows that the probability of these small spills over the life of the project is essentially 1.0; that is, they do and will occur. However, based on the empirical experience of the North Slope oil companies as well as the experience of oil field operations in the contiguous United States, the chance of a very large spill greater than 1,000,000 gallons is extremely low, and even the probability of a very large spill over 100,000 gallons is low. Most spills have been contained on gravel

---

[4] In the context of oil and other hazardous material spills (e.g., antifreeze), abandonment and restoration/rehabilitation activities are generally similar to construction activities. Most spills will result from vehicle accidents, vehicle refueling and servicing, and storage of fuels for vehicles. Oily residues from cleaning of abandoned pipelines may also be spilled in vehicle accidents and truck rollovers. For this EIS, impacts described for construction activities are generally applicable to abandonment, restoration, and rehabilitation activities.

[5] For this EIS, “well blowout” refers to the uncontrolled release of oil/gas/brine and drilling fluids during the well drilling or well workover phases. Once a well is drilled and the wellhead and surface safety valve are in place, the loss of produced fluids is termed an “uncontrolled release.” For this EIS, it is the loss of fluids (e.g., oil and brine) that are the primary environmental impact concern. The loss of natural gas is a minor environmental issue because it evaporates and disperses quickly, though it may be a safety issue.

[6] For this EIS, Harrison Bay boundary extends east to Oliktok Point, west to Cape Halkett, and north to the line drawn between these two points. The area beyond that is considered the nearshore Beaufort Sea.

pads and roadbeds (NRC 2003). Most of those that have reached the tundra have covered fewer than 5 acres (BLM and MMS 1998b). Upon detection, spills that have occurred were promptly contained and cleaned up as required by state, federal, and borough regulations (NRC 2003). Impacts that have occurred were judged minor, and natural and/or anthropogenic-assisted restoration have generally occurred within a few months to years (NRC 2003).

4.3.2 BACKGROUND FOR OIL, SALT WATER, AND HAZARDOUS MATERIAL SPILLS

4.3.2.1 Introduction

This section presents a general discussion of the impact of potential spills. The section is structured as follows:

- First, a brief history of oil, salt water, and other spills on the North Slope is provided as background (Section 4.3.2.2).
- Second, the spill characteristics and assumptions used to develop the scenarios for spill rate, characteristics, and impact assessment are described (Section 4.3.2.3). These include size, type of material, type or source of the spill, seasons, and location relative to oilfield infrastructure.
- Third, the rate of spills is discussed (Section 4.3.2.4). The impact of a potential spill is based upon the likelihood or rate that a spill would occur and the severity of that spill. This section discusses the rate of spills based upon the industry operating record on the North Slope, probability and risk analyses performed for other North Slope projects, and considerations specific to the CPAI Development Plan and FFD.
- Fourth, the behavior and fate of spilled material is assessed (Section 4.3.2.5). Behavior and fate depend upon the type of material released and the nature of the receiving environment. This section identifies the type of materials that could be spilled and discusses their chemical and physical properties that influence their behavior in the natural environment. This section also provides a general description of the receiving environment, the seasons, and associated conditions that would influence spill behavior and fate.
- Fifth, potential exposure to the spilled material and its effects on the environment are evaluated (Section 4.3.2.6). In many cases, exposure of various habitats would depend upon the spill location. Similarly, effects of exposure would depend upon the habitat and associated plant and animal species exposed.

A more detailed resource-by-resource impact assessment for each of the alternatives and the FFD is provided in Section 4.3.3.3.

4.3.2.2 History of North Slope Spills

The recent NRC report on “Cumulative Environmental Effects of Oil and Gas Activities on Alaska’s North Slope” (NRC 2003) summarizes the history of North Slope oil spills by stating that “Major oil spills have not occurred on the North Slope or adjacent areas as a result of operations [of the oilfields]. … Many small terrestrial spills have occurred in the oilfields, but they have not been frequent or large enough for their effects to have accumulated.” Appendices F and G of the same NRC report provide the most recent detailed analysis of risk, size, type, and general impacts of North Slope oil and salt water spills. These analyses are the basis for the conclusion quoted.

A key conclusion of Maxim and Niebo (2001a, 2001b, 2001c)[7] is that, although oil and salt water spills on the North Slope continue to occur and the total annual volume of oil spilled fluctuates substantially, there is nevertheless a general decreasing trend over a 30-year oil-field operating history in the total volume of oil spilled. This trend occurs despite better reporting of all sizes of spills, especially the small spills, and despite aging of much of the oilfield infrastructure. Maxim and Niebo attribute this trend to improved technology, better engineering design, greater stress on clean operations, and greater awareness on the part of all the oilfield

---

[7] Maxim and Niebo were the primary contributors to the detailed analysis of oil and brine spill risks as presented in the NRC report Appendices F and G, as well as that presented in the TAPS EA (TAPS Owners 2001a).

personnel. Increasingly stringent federal, state, and borough regulatory requirements for reporting spills, as well as for preparation of response plans and training, also contribute to the declining long-term trend in total spill incidents. Maxim and Niebo do not analyze the trends in the number or size-frequency of spills, especially the smaller volume ones, partly because of the changes in the way spills have been reported over the 30-years-plus record and partly because the important environmental variable, in their opinion, is the volume spilled.

Mach et al. (2000) reviewed several data bases on oil spills that took place on the Alaska North Slope, Arctic Canada, and the Trans-Alaska Pipeline between 1970 and 1999[8]. Their analysis found 126 spills greater than 4,200 gallons, with 111 of them in Alaska. Nine North Slope spills were greater than 21,000 gallons. The researchers found that "… Alaskan oil spills most frequently are associated with highway tank vehicle accidents and operations support facilities, followed by [oil] spills related to construction camps, operations support facilities, and pipelines. [Fewer] Spills [were] associated with oil production processing facilities, oil production wells, pipeline pump stations, and exploration activities…." They also note that "A general check on the fluctuation of the data set indicated spill occurrence to be quite random. There appeared to be little difference in the size of spills associated with the various facilities, … [except that pipelines had larger spills]". The analysis suggests that "...crude oil spills tend to be larger than other types of spills." It was also noted that "…statistical analysis of individual spill volumes [did not indicate any correlation with location], facility type, oil type, affected [environment], and spill cause." Finally, the analysis showed that more large oil spills occurred between 1975 and 1979 (TAPS operation began in mid-1977) and that the rate of spills greater than 4,200 gallons dropped to a more or less constant rate from 1980 on.

A review of the ADEC spill database from January 1, 1995, to August 18, 2003, (provided by Camille Stephens, ADEC, through Ken Taylor, ADNR, in September 2003 and hereafter referenced as ADEC 2003d[9]) for the North Slope shows 3,673 spill records[10] including oil, salt water (composed of brine from produced waters and treated seawater), and other hazardous materials, as well as a few "freshwater" spills. The database is probably a fair representation of the type, size, location, and cause of spills that one might expect from North Slope oilfield operations in the near future. For oil spills (including produced fluids, crude oil, refined products, and lubricants), the ADEC database reflects the trends described by Maxim and Niebo (2001a, 2001b, 2001c). For salt water spills (including treated seawater, produced fluids, and brine), the number and size of spills fluctuated from 1995 through 2001 and has shown a generally decreasing trend since that time.

The 3,673 spill records from the ADEC and annual oil production volumes obtained on April 6, 2004, from the Alaska Department of Revenue (ADR) website (www.tax.state.ak.us/programs/oil/production/historicaldata/prodCYFY.htm#FYCYANS) are distributed on a calendar-year basis as shown in Table 4.3.2-1.

The average number of records by year for spills over the 8.6-year period (January 1995 to August 2003) is approximately 417 with a range of 226 in 1995 to 615 in 2002 (ADEC 2003d). At the current rate, one might expect approximately 282 spills in 2003.

Of the 3,673 spill records in the ADEC database, no spill was greater than 1,000,000 gallons. Only one spill was greater than 100,000 gallons. In March 1997, 994,400 gallons of salt water "spilled" at DS 4 in the Prudhoe Bay Unit when salt water broached to the surface and was completely contained on the pad (B. Smyth, pers. comm. plus excerpts of the Incident Report of the Investigation Team). Additional records show 22 spills greater than 10,000 gallons of which two were crude oil (approximately 38,000 and 30,000 gallons), one was diesel (18,000 gallons), nine were drilling muds (composed of four incidents with six records for one incident), and six were salt water. Four other releases were reported as greater than 10,000 gallons including Halon and natural gas

---

[8] Mach et al. (2000) did not analyze salt water spills which have been the largest volume spills on the Alaska North Slope.

[9] The database was provided on a CD. This EIS took the database at face value and did not attempt to verify each record, resolve all apparent inconsistencies and conflicts in reporting, classification, etc. The ADEC is aware of the database limitations and is in the process of correcting them (B. Smyth, pers. comm.). For purposes of the analyses contained in this EIS, these limitations and inconsistencies are not expected to result in substantial changes to the results or conclusions though some of the details as well as accuracy and precision of results might change. In any case, the ADEC database is the best information currently available to us and the public.

[10] There are duplicate and even as many as six records for the same incident. According to Luick (ADEC, pers. comm., 2003), this is an artifact of the database structure that occurs when the same incident involves more than one listed substance. The number of replicated incidents is small and does not materially change the discussion provided in this section.

(both gases) and reserve pit gravel. There were 112 records of spills of 1,000 to less than 10,000 gallons, 411 records of spills 100 to less than 1,000 gallons, 912 records of spills 10 to less than 100 gallons, and 2,215 records of spills less than 10 gallons. Of the latter, 498 records (23 percent) were reported as less than or equal to one gallon. By far the majority of spills since 1995 have been very small to small ones.

TABLE 4.3.2-1 ADEC 1995–2003 DATABASE SPILL RECORDS AND ADR ANNUAL OIL PRODUCTION VOLUMES

Year	Number of Spill Records	Annual Cumulative Spill Volume (millions of gallons)[c]	Annual Oil Production (millions of gallons)[d]
1995	226	0.057193	22,329
1996	438	0.086035	21,997
1997	470	1.079037	20,440
1998	442	0.131229	18,493
1999	381	0.097234	16,517
2000	396	0.116010	15,332
2001	505	0.214543	15,235
2002	615	0.148413	15,356
2003	~282[a]	~0.045000[a]	10,154e
TOTAL	~3755[b]	~1.974694[b]	155,853
Average	417	~0.219410	~17,997

Notes:

[a] The database shows 200 records through mid-August 2003; extrapolating that rate to the end of the year approximates 282 records. The database also shows 29,812 gallons spilled through mid-August 2003 and extrapolation to the end of the year approximates 45,000 gallons.

[b] Because of the extrapolation to the end of 2003, the total estimated number of records is greater than the actual number of records in the database and the total amount spilled is larger than the actual amount reported in the database through August 2003.

[c] A few spills are recorded as pounds instead of gallons. For this table, units are assumed to be the same (e.g., 10 gallons of seawater and 10 pounds of drilling mud are counted as 10 units each.

[d] These oil production volumes are from the ADR Tax Division web site (ADR 2003c), using the calendar year data for Alaska North Slope crude oil.

[e] These data were compiled from the ADR website through August 2003 to match with the ADEC spill database that ended in mid-August 2003.

Since March 1998 when APF-1 began operations, the ADEC database (ADEC 2003d) shows 54 records of spills associated with APF-1 through August 8, 2003. This averages approximately 12 spills per year. One salt water spill was reported as 4,998 gallons, three spills of aviation gas or hydraulic fluid were reported at 100 to 1,000 gallons, 19 spills were reported at 10 to less than 100 gallons including diesel, hydraulic fluid and ethylene glycol (antifreeze), and 31 spills were reported at less than 10 gallons of various materials. Most of these spills were on pads or roads and were associated with routine operations. They were generally the result of human error or equipment failure. According to the CPAI ODPCP (CPAI 2003), while the underground Colville River pipeline crossing was being drilled, one spill of drilling mud in March 1999 did not leave the ice pad; it was not related to oil well drilling. Three spills (100, 210, and 252 gallons) of oil or diesel did reach the tundra. All spills were reported and cleaned up.

There have been no blowouts or uncontrolled releases of produced fluids at APF pads since drilling was initiated (CPAI 2003).

North Slope-wide, Fairweather (2000) (quoted in Appendix F, NRC 2003) reported five events from 1971 to 2001 that resulted in uncontrolled surface release of liquids or gas from the boring. None of these events resulted in oil spills (Mallary 1998). Over this same period, approximately 5,000 wells were drilled or re-drilled, giving a rate of approximately one event per 1,000 wells drilled or a probability of approximately 0.001, about the same as for other areas (Mallary 1998, S.L. Ross 1998). The conclusion is that blowouts and uncontrolled releases have been rare events and are likely to be even rarer in the future as BACT is applied to future drilling and production activities.

4.3.2.3 Basic Assumptions for Spill Impact Assessments

The discussion of the impacts of spills requires description of the several basic assumptions and classifications related to the spills themselves and to the environmental variables that might affect the spill impacts. These descriptions are provided with the caveat that they are necessarily simplified and might not represent the entire spectrum of possible values or combinations of values and events that might be realized in actual spills. However, many of these assumptions have been used in previous assessments and all are based on the empirical experience of oil spill experts on the Alaska North Slope and elsewhere.

SPILL SIZE CLASSIFICATION

To describe the impacts of spills in this EIS, spills were categorized as:

- Very small spills – less than 10 gallons (approximately 0.25 barrels[11] or bbl)
- Small spills – 10 to 99.5[12] gallons
- Medium spills – 100 to 999.5 gallons
- Large spills – 1,000 to 100,000 gallons
- Very large spills – greater than 100,000 gallons.

This size classification is similar to the unofficial “rule of thumb” used by the ADEC when they respond to and evaluate spills of oil and hazardous materials (B. Smyth 2003, pers. comm.). The very small spill and very large spill categories were added to facilitate discussion of the majority of spills (less than 10 gallons) and of the very rare spills (greater than 100,000 gallons); the latter are discussed in more detail in Section 4.3.4.

TYPES OF MATERIALS SPILLED

For this EIS, the potentially spilled materials are categorized and described as follows:

- Produced Fluids – composed of crude oil, natural gas, brine, and formation sand. (Note that the crude oil in produced fluids from the CPAI Development Plan and probably FFD is generally lighter, has more volatiles, and is sweeter than several other North Slope crude oils including Endicott, Milne Point, and North Star (Leirvik et al. 2002). Also, formation pressures in the Alpine fields are less than fields to the east.)
- Crude (=Sales[13]) Oil (from FFD only) – oil separated from the brine, natural gas, formation sand, and other impurities and then transported to the Trans-Alaska Pipeline and eventually to the Valdez Marine Terminal.
- Refined Oil – includes Arctic diesel, Jet-A 50 (which is very similar to diesel), unleaded gasoline, hydraulic fluid, lubricating oil and grease, transmission oil, waste oil, mineral oil, and other products.
- Salt Water – composed of treated seawater from the Kuparuk STP at Oliktok Point and brine separated from the produced fluids. (For this EIS, salt water is used as a general term to include seawater, brine in produced fluids, and other saline solutions unless there is a specific reference to the seawater alone).
- Seawater – specifically the treated seawater from the Kuparuk STP at Oliktok Point.
- Other Hazardous Materials – includes methanol, antifreeze (tetraethylene glycol or TEG), water soluble chemicals, corrosion inhibitor, scale inhibitor, drag reducing agent (e.g., Dra Flo XL) , and biocides[14].

---

[11] One barrel contains 42 gallons. Gallons are used throughout this section.

[12] Any spill of 99.5 – 99.9 gallons is considered a 100 gallon spill, i.e., spill volume is rounded to the nearest gallon.

[13] Sales Oil is the crude oil from the produced fluids with the brine, grit, natural gas, and other impurities removed before the crude oil is transported to the Trans-Alaska Pipeline and eventually to the Valdez Marine Terminal.

The ADEC Spill Database also includes spills of Halon, drilling muds, gravel, fresh water, bentonite, and natural gas. Halon is a gas and its use on the North Slope has been discontinued. Natural gas is also a gas that dissipates rapidly in the atmosphere and has little to no impact on the natural resources. Fresh water is a major constituent of the normal habitat and has little to no environmental impact. Gravel spills occur on or adjacent to roads and pads; they are at most a small areal extension of the impacts described for these structures in Section 4A.3.1 through Section 4F.3.1 Drilling muds, including bentonite, are primarily clay and water and most releases are on or adjacent to roads or drilling pads. Like gravel, the impacts are a small areal extension of the impacts described for these structures in Section 1.3.2.4.

The impact assessment is based primarily on spills of produced fluids (sometimes referred to as crude oil spills in some of the North Slope literature), refined products (primarily diesel and hydraulic oil), and salt water. These materials are the most likely to spill in sufficient volume and frequency at locations where the spilled material could reach the natural environment and could result in impacts to that environment and its resources. Hence, most of the data on spills on the North Slope (and elsewhere) are on "oil" spills and, to a lesser extent, on salt water spills.

PHASE OF OILFIELD DEVELOPMENT

Where appropriate, this EIS considers potential spill impacts associated with the construction, drilling, production, operation, abandonment, and restoration/rehabilitation phases[15] of the oilfield development separately. This is relevant because some sources and sizes of spills would not occur in some phases or would more likely occur in one phase than another. For example, during construction, most of the spills would be relatively small, consist of diesel, hydraulic fluid, antifreeze, lubricating oils, and similar materials associated with the vehicles and construction equipment on site or in transit to and from the site (NRC 2003, Mach et al. 2000). Once construction and drilling are completed, the likelihood of spills and leaks from vehicles and heavy equipment would be reduced because vehicle and equipment activity would be reduced during production and operations relative to construction and drilling, and the volumes of refined products and most chemicals being transported are reduced. In addition, blowouts would not occur during construction and, if they were to occur at all, would occur during the drilling phase. Uncontrolled releases could occur during exploration and development drilling. Spills of produced fluids and salt water would only occur during the production phase.

SEASONS

The season in which a spill occurs might dramatically influence its behavior, impacts, and the cleanup response actions. This EIS considers spills in four seasons.

Summer (Ice-Free)

Summer is confined to the ice-free period when most of the rivers and creeks are flowing; ponds, lakes, and Harrison Bay are open water; tundra is snow-free; and biological use of tundra and water bodies is high. Currents, winds, and passive spreading forces would disperse spills that reach the water bodies. Spills to tundra would directly affect the vegetation, although the dispersal of the spilled material is likely to be impeded by the vegetation. Spills to wet tundra may float on the water or be dispersed over a larger area than would spills to dry tundra or to snow-covered tundra. Spills under pressure that spray into the air may be distributed downwind over substantial areas and impact the tundra vegetation and water bodies.

---

[14] Sewage spills are not included in this section but they are considered in the anlyses of impacts to the different resources. They are not included in the ADEC database because they do not constitute a hazardous substance, oil, or salt water. Most sewage spills are small and occur at the facilities on the gravel pads. Also, sewage is discharged under an NPDES permit and, by regulation to meet applicable water quality standards, typically does not contain hazardous substances above specified limits.

[15] Refer to footnote 3.

Fall (Freeze-Up)

Freeze-up is the period when the water bodies are beginning to ice over but the ice cover might come and go depending upon temperature, wind, currents, and river flow velocities. Snow begins to cover the tundra and most of the migratory birds are leaving the North Slope. Spilled material could be dispersed when it reaches flowing water but slowed or stopped when it reaches snow or surface ice. The spilled material could be contained by the snow or ice but dispersed if this ice breaks up and moves before it re-freezes. The spilled material also could flow into ice cracks to the underlying water where it could collect.

Winter (Ice Cover)

Winter is the long, dark period when water bodies including Harrison Bay and the Colville River are covered with mostly unbroken ice, and snow covers the tundra. Dispersal of material spilled to the tundra generally would be slowed though not necessarily stopped by the snow cover. Depending upon the depth of snow cover as well as temperature and volume of spilled material, it may reach the underlying dormant vegetation or tundra ponds and lakes. Similarly, spills to rivers and creeks generally would be restricted in areal distribution by the snow and ice covering the water body, compared to seasons when there is little or no snow and ice cover. Spills under the ice to creeks, rivers, and tundra ponds/lakes might disperse slowly as the currents are generally slow to non-existent in the winter.

Spring (Break-Up)

Break-up is the short period in the spring when thawing begins in the higher foothills of the Brooks Range and river flows increase substantially and quickly, often to flood stages. These increased flows cause the river ice cover to break up and flow downriver, eventually to Harrison Bay. The river floodwaters usually flow over the sea ice of Harrison Bay, which hastens the break-up of the sea ice. Snow cover begins to melt off the tundra and many of the migratory species, especially birds, return to the tundra. Spills to water bodies during break-up are likely to be widely dispersed and difficult to contain or clean up. Spills to the tundra might be widely dispersed if the flooding overtops the river and creek banks, and entrains the spilled material.

WEATHER, WINDS, AND WATER LEVEL

Weather, especially rapid warming periods and/or heavy rainfall, may cause snowmelt and/or runoff that could result in flooding of the tundra lakes/ponds, major creeks and the Colville River Delta channels. If spilled material is released to the flooded area, especially to flowing waters, the material could be distributed to adjacent terrestrial and tundra pond/lake habitats that are normally not exposed. The habitats and natural resources as well as human uses of the habitats and resources may be exposed to the spilled material.

High wind velocity may result in widespread distribution of any material released under pressure, primarily from pipelines or blowouts and uncontrolled releases. The material would spray out and become a cloud of mist and fine particles that would be carried downwind. The extent of the distribution will depend upon wind velocity and the direction of the released spray (e.g., downward into the tundra, horizontal, or skyward).

Water levels in the Colville River Delta as well as Harrison Bay may increase or decrease substantially over normal flow and tidal levels, depending upon the duration and strength of wind storms. A spill occurring at high water levels may have distribution and impacts similar to that occurring from flooding described above.

LOCATION OF SPILLS

Most spills would occur on or in close association with the oilfield infrastructure. For convenience, the locations are classified as follows:

- Gravel pads for drilling, production and processing facilities
- Gravel roads (including culverts)
- Gravel airstrips
- Temporary ice roads and ice pads
- Pipelines
- Bridges

Most spills, except from pipelines, would occur and be contained on or immediately adjacent to the ice or gravel pads, roads, and airstrips, and they would be promptly cleaned up as required by federal, state, and borough regulations before they reach the tundra or water bodies. Some spills from vehicles, including fuel and other tank trucks running off the roads, may result in much or all of a load being spilled to the tundra, tundra ponds and lakes, or flowing water bodies adjacent to the road or pad.

Most pipeline spills will occur at some distance from the nearest road or pad, especially in Alternative D and B, and for CD-1 to CD-3 pipeline route for Alternatives A, B, D, and F. Much less likely are spills from other sources (e.g., aircraft crash) that would occur any substantial distance from one of these structures. Also, material released under pressure from a pipeline during high wind events could result in the spilled material being blown over a wide area of tundra, often remote from access roads.

POTENTIAL SOURCES OF SPILLED MATERIAL

The main sources of spilled material from the proposed CPAI Development Plan facilities would include the following:

- Alpine production pads CD-3 through CD-7 would include storage tanks and containers, gas and salt water injection facilities, and produced fluids pumping facilities. The size, contents, and secondary containment for the storage tanks and containers at the drilling and production pads (and HPF-1 and HPF-2 in the FFD) are described in Sections 2.3.3.1 and 2.2.12.3. Because of the secondary containment around the storage tanks and containers, it is very unlikely that catastrophic failure of one or more storage tanks could be a potential source of a spill large enough to leave the pad. However, as a worst-case scenario in the ODPCP (CPAI 2003), such a spill is considered possible if the secondary containment were breached. Processing facilities also store chemicals such as methanol and antifreeze.
- In-field pipelines for produced fluids, diesel, and salt water connect the various production pads to the process facilities at APF-1. The produced fluids pipeline would contain crude oil, natural gas, and produced water. The salt water pipelines would contain either treated seawater or a blend of treated seawater and brine from the produced fluids. The products pipeline would be used to distribute various types of diesel to the CD-3 production pad in Alternative A. The MI pipelines would contain light hydrocarbon fluid that may have a range of liquid to gas content. If released, the gaseous component would dissipate in the atmosphere and would not cause impact to natural resources except for the potential for a fire that could subsequently damage an adjacent pipeline and cause a release of another material. The liquid component of the MI would be sprayed under pressure as a mist and may impact resources and habitat downwind of the source. The lift gas pipeline would transport natural gas from the central processing facility to the production pads for use as fuel gas and/or to lift produced fluids in the well bore.

- Vehicles including light- and heavy-duty trucks and tank trucks, aircraft (fixed-wing and rotary), watercraft, snow machines, and heavy equipment might spill or leak fuels (diesel, gasoline, jet), oils (motor, transmission, hydraulic), and antifreeze from unintentional releases during refueling and maintenance, leaks and drips during normal operations, or releases related to vehicle or equipment accidents. With the exception of vehicles leaving the pads or roads (e.g., tanker rollover, vehicle accident), impacts from these types of spills generally would be confined to small areas on airstrips, ice pads, and gravel roads or gravel pads where containment and cleanup could be easily accomplished. Spills from snowmobiles might occur on the tundra remote from roads and pads, but the volumes would be small and the snow would generally contain it. Spills from watercraft also would be relatively small.

The main sources of spilled material from the hypothetical FFD facilities include all the sources listed above for the CPAI Development Plan and a potential additional salt water pipeline and sales oil pipeline, if new processing facilities are developed along with associated production pads and pipelines. In the FFD, the extended Sales Oil and treated salt water pipelines would extend from CD-1 to HPF-1 and HPF-2 if they were built (Section 2.3.2). An FFD sales oil pipeline from National Petroleum Reserve-Alaska would not necessarily connect to the existing sales oil line between KRU and APF-1. The connection would depend upon the production rates of the FFD processing facilities and the capacity of the existing Alpine sales oil line at the time. In the complete development of the FFD, the additional FFD pipelines would cross at least five major rivers (i.e., Kalikpik River, Fish-Judy Creeks, Ublutuoch River, and the Nigliq Channel). The FFD Sales Oil pipeline would contain at least 10 vertical loops, one on each side of these rivers (Section 2.3.2 for further details).

Well blowouts and uncontrolled releases are an additional but low-probability potential source of spilled production fluids (NRC 2003). Blowouts could occur during well drilling and uncontrolled releases could occur during production activities including workover operations. A well blowout could result in a potentially large to very large volume spill of produced fluids (crude oil and brine) over an extended period. Fluids released by a well blowout or uncontrolled release could extend beyond the limits of the gravel production pad anywhere in the Plan Area under the proposed CPAI Development Plan or FFD and could potentially reach nearby ponds, lakes, creeks, and/or rivers with a potential to enter the marine environment in Harrison Bay.

4.3.2.4 Rate of Spills

The likelihood of a spill is determined based upon the rate or frequency of occurrence. The rate of occurrence is a function of several factors including age of the infrastructure, operating procedures, personnel training and awareness, maintenance, and human error. Impact analyses typically are presented in various scenarios to span the range of rate or probability of occurrence. Rate is expressed in several ways; for example, “once in 1,000 years,” “once in one billion barrels (or gallons) of oil produced,” or “once per 10,000 wells drilled.” This EIS analyzes the potential impacts of a range of possible spills including the very low likelihood, very large volume spills. This section presents a general discussion of rate or probability of spills associated with North Slope oilfield construction, drilling, and production, and includes discussion of the more likely spills, mostly very small to small ones. The very low likelihood, very large volume spills (VLVS) and their impacts are discussed separately and in more detail in Section 4.3.4.

RATE OF VARIOUS SIZES AND TYPES OF SPILLS

A review of the several EISs and similar documents referenced in Section 4.3.1 indicates that the probability of very small, small, and even medium size spills is relatively high, with the probability of very small and small spills being 1.0 over the life of the CPAI Development Plan and/or the FFD, i.e., they will occur. The probability of large spills is substantially less, i.e., there will be fewer large spills, but there is likely to be at least one and probably more over the life of the projects. Finally, based on past experience on the North Slope, the probability of a very large spill is very low and might approach 0.0 as the size of the potential spill increases. The qualitative assessment of potential rate of occurrence is provided in Table 4.3.2-2. The relative ranks are based on: the experience of several personnel with extensive oil spill background with spills, peer-reviewed and “gray” literature, USCG spill reports; the reports incorporated by reference earlier; and other spill reports for North Slope incidents. The assessment is a subjective evaluation and the categories are relative to each other in the context of North Slope oil field operations.

The rest of this section provides the background information for the potential rate of occurrence of various size spills. The rate is based on rate, probability, and risk analyses prepared for other EISs and reports that are incorporated earlier by reference, and by the size and proportion of spills that are recorded in the ADEC database for North Slope spills from January 1995 to August 2003. The relevant information from the ADEC database (ADEC 2003d) is summarized in Table 4.3.2-3.

For this EIS, the rate of each type of material spill, regardless of the volume, may be estimated using the ADEC 1995 to 2003 spill database and the ADR data on oil throughput since 1995. The rates are shown in Table 4.3.2.2 and are expressed as rate of occurrence of a spill of each category of material per billion gallons of oil transported from Pump Station 1. The rates range from less than 0.1 (less than one in 10 billion gallons of oil transported) to 5.3 (approximately one in 0.19 billion or 190 million gallons of oil).

CRUDE OIL

For this analysis, the "crude oil" category includes oil in the produced fluids (which also contain brine that would likely be spilled at the same time), as well as the Sales Oil Pipeline (FFD only).

In the Northeast National Petroleum Reserve-Alaska IAP/EIS (BLM and MMS 1998b) and based on data for spills on the North Slope from January 1989 to December 1996, the BLM estimated the average crude oil spill at approximately 160 gallons and the median size at approximately 7 gallons. The size range was 1 gallon to 38,850 gallons. Approximately 99 percent of the spills were less than 1,050 gallons and no oil spill was greater than 42,000 gallons. For the Northeast National Petroleum Reserve-Alaska IAP/EIS, the BLM assumed the average crude oil spill was 168 gallons (4 bbls). They also assumed that a very large spill (using the BLM spill size categories) from a pipeline was 117,600 gallons (2,800 bbls) spilled over a 30-day period.

In the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 1998), and based on data for spills on the North Slope from January 1989 to December 2000, the BLM estimated the average crude oil spill at approximately 113 gallons and the median size at approximately 5 gallons. The size range was 1 gallon to 38,850 gallons. Approximately 99 percent of the spills were less than 2,520 gallons and, again, no spill was greater than 42,000 gallons. For the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS, the BLM assumed the average small crude oil spill was 126 gallons. The BLM also assumed that the large crude oil spill was 21,000 gallons from a pipeline spill.

Mach et al. (2000) estimated the rate of oil spills (including crude oil spills) to range from 0.0053 +/-.24 percent spills per 42,000,000 gallons of crude oil produced for a spill of less than 4,200 gallons (a large spill as defined in this EIS) to 0.000078 +/-200 percent spills per 42,000,000 gallons of crude oil produced (a very large spill as defined in this EIS). They did not provide spill rate estimates for very small to medium spills.

The CRU Satellite Development Environmental Evaluation Document (EED) (PAI 2002a), and the Liberty EIS (BLM and MMS 2002) report ranges of values for the small and large spills of crude oil that are similar to, or the same as, those in the National Petroleum Reserve-Alaska EISs cited above and incorporated by reference.

TABLE 4.3.2-2 RELATIVE RATE OF OCCURRENCE FOR SPILLS FROM MAIN SOURCES

Source Pipeline	Spill Size Very Small (<10 gal)	Small (10–99.5 gals)	Medium (100–999.5 gal)	Large (1,000–100,000 gals)	Very Large (>100,000 gals)
Produced Fluids	H	H	M	L	VL
Salt Water	H	H	M	L	VL
Diesel	H	M	L	VL	0
Sales Oil (FFD only)	M	M	M	L	VL
Bulk Storage tanks & containers on pads	L	L	L	VL	0
Tank vehicles	H	M	L	VL	0
Vehicle & Equipment Operation and Maintenance	VH	VH	M	VL	0
Other Routine Operations	VH	VH	H	L	VL
Drilling Blowout	VL	VL	VL	VL	VL
Production Uncontrolled Release	VL	VL	VL	VL	VL

Notes:

VL = Very Low rate of occurrence (approaching 0.0)
L = Low rate
M = Medium rate
H = High rate
VH = Very High rate (approaching 1.0)
0 = will not occur

TABLE 4.3.2-3 TYPE, NUMBER, SIZE, PERCENTAGE, AND RATE OF SPILLS IN ADEC 1995 TO 2003 NORTH SLOPE DATABASE

Material	No. Records[a]	Size (gal) of Largest Spill	% of All Records [b]	Spill Rate per billion gallons oil transported in TAPS[e]
Crude Oil	422	38,000	11.5	2.7
Diesel	820	10,000	22.3	5.3
Hydraulic Oil	630	660	17.2	4.0
Engine Lube	178	650	4.8	1.1
Transmission Oil	39	75	1.1	0.3
Waste Oil	13	1,500	0.4	<0.1
Gasoline	19	100	0.5	<0.1
Other Refined Products[c]	48	5,700	1.3	0.2
Salt Water	121	994,400	3.3	0.8
Produced Water	172	92,400	4.7	1.1
Propylene/Ethylene Glycol	268	5,700	7.3	1.7
Drilling Muds	207	20,000	5.6	1.3
Methanol	197	2,520	5.4	1.3
Others[d]	539	30,000	14.7	3.6

Notes:

[a] Number of records in the January 1995 to August 2003 ADEC database (ADEC 2003 d).

[b] Based on total number of records for each material out of the total of 3,673 spill records in the ADEC 1995–2003 database

[c] Includes asphalt, aviation fuel, grease, kerosene, synthetic oil, transformer oil, and turbine fuel.

[d] Includes Halon (a gas no longer used on North Slope), corrosion inhibitors, drag reducing agents, chemicals, acids, alcohols, natural gas, therminal, water, unknown, and “others” (of which about 70 could be identified as salt water of some type).

[e] For the 1995 to 2003 period of the ADEC database, approximately 156,000,000,000 gallons of oil were transported. The rate in column 5 is based on dividing the number of records (column 2) by 156.

The ADEC North Slope spill database (ADEC 2003d), for the period of January 1995 through August 2003, includes 3,673 records. The two largest of the 422 crude oil spill records were 38,000 and 30,000 gallons. Using the size categories described earlier in this EIS (Section 4.3.2.3) and Table 4.3.2-2, there were 10 other large spills, 67 medium spills, 145 small spills, and 196 very small spills. Some of the reported crude oil spills could be associated with produced fluids or produced water, making it impractical to determine how much of the spilled material was actually oil.

The largest oil spill reported by CPAI (CPAI 2003) was 275 gallons at CD-1 Pad.

For the analysis of the CPAI Development Plan and the FFD, it is assumed that:

- The probability of very small and small spills is 1.0 and the size of these spills is 5 and 60 gallons, respectively. These l spill volumes are an arbitrary designation of the midpoint in the spill volume range (e.g.., less than 1 gallon to less than 10 gallons). Based on the ADEC database, the proportion of these very small and small oil spills is approximately 9.3 percent[16] of all the spill records since 1995.
- The rate of medium spills (i.e., 100 to 999.5 gallons) is approximately 1.8 percent based on the ADEC database.
- The size of a large spill is between 1,000 and 100,000 gallons, which includes the value of 38,850 gallons used in the Northeast National Petroleum Reserve-Alaska IAP/EIS (BLM and MMS 1998a). This value is close to the two largest crude oil spills reported in the ADEC database since 1995 (see above). The rate of a large spill is 0.3 percent; 12 out of 3,673 records for the entire database. The rate of the two largest crude oil spills is 0.05 percent.

The actual amount of crude oil in the reported volumes for crude oil spills in the ADEC database might be an overestimate in some cases because the spills could have been produced fluids of which part of the volume spilled was salt water.

REFINED HYDROCARBONS

For this analysis, the “refined hydrocarbon” category includes Arctic diesel, Jet A-50, hydraulic oil, lube oil and grease, transmission oil, waste oil, unleaded gasoline, mineral oil, and other refined products. The number of records, maximum size, and percentages that each of these spill types constitute of all spills on the North Slope since 1995 are shown in Table 4.3.2-3.

The average spill size has been estimated at 29 gallons (BLM and MMS 1998b; BLM and MMS 2003; PAI 2002a) and diesel spills account for most of the spills in frequency and total volume (BLM 2003b). Of the 820 diesel spills listed in the ADEC database (ADEC 2003d), 18 were large (greater than 1,000 gallons) with the largest at 10,000 gallons; 70 were medium (100 to 999.5 gallons), 272 were small (10 to 99.5 gallons) and 460 were very small (less than 10 gallons).

Hydraulic oil, engine lube oil, and transmission oil spills, though relatively numerous (847 or 23 percent out of 3,673 records) are generally small (maximum reported size was 660 gallons) and confined to the pads. Gasoline spills are small and infrequent because diesel is the most prevalent equipment fuel. Waste oil and “Other Refined Products” also are relatively infrequent (51 or 1.4 percent of 3,673 records) and most are very small and small spills, with one medium spill.

Because these spills are small, unpredictable in time and location, mostly occur on gravel pads or roadways, and cannot spread far, the impacts are not anticipated to be cumulative. Therefore, they are evaluated as individual spills of approximately 100 gallons each.

In the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003), the BLM assumed that a large spill of diesel from an onshore bulk storage tank would be 37,800 gallons. Based on the project description for the CPAI Development Plan and the FFD, and assuming that the entire contents of the storage tank could be spilled onto the environment (that is, the secondary containment fails completely), the maximum spill of diesel could be 4,200 gallons at any production pad and 15,000 gallons for the FFD processing facilities (Section 2.). For the analysis of the CPAI Development Plan and the FFD, a large diesel spill is assumed to be 15,000 gallons.

---

[16] As an example, calculated as (146 + 197/3,673) 100 percent = 9.3 percent.

SALT WATER

Data and/or analyses of the existing data is limited concerning frequency, location, volume, or causes of salt water spills, whether it is seawater from the STP, brine in the produced fluids, or the blended brine and seawater that is re-injected into the oilfield. The risk of salt water spills from pipelines generally can be addressed by the same approach as produced fluids. Qualitatively, the likelihood of a salt water spill is similar to the likelihood of a produced fluids spill because the lines are collocated, the materials transported have approximately the same corrosivity, and the other causes of pipeline leaks are human or mechanical in nature. The produced fluids pipelines are also subject to internal erosion from the formation sands.

The ADEC database for spills on the North Slope from 1995 to 2003 (ADEC 2003d) shows 121 salt water and 172 produced water spills (approximately 8.0 percent of all spill records) with the largest spills being 994,400 and 92,400 gallons, respectively. Most were very small (40 incidents) to small (49) spills[17].

OTHER MATERIALS

Other spilled materials in the records of the ADEC database (ADEC 2003d) include drilling muds, methanol, propylene and ethylene glycol (antifreeze), Halon, corrosion inhibitors, drag reducing agents, other chemicals, acids, source water, unknown, and "other." These account for approximately 558 or 15.2 percent of the records. A few large spills have occurred of some of these materials (e.g., drilling muds at 18,900 gallons, ethylene glycol at 5,700 gallons, drag reducing agent at 6,000 gallons) but most of the spills have been small or very small. Most of these spills were contained on and cleaned up at the pad or road where they occurred.

The rate of a spill of one of the "Other Materials" is relatively high (approximately 15 percent of all spills) but the volumes are relatively low and most occur on pads or roads.

4.3.2.5 Behavior and Fate of Spilled Materials

This section describes primarily the properties and behaviors of spilled oil that are important to the evaluation of the potential effects that the spilled oil might have in the various environments in the Plan Area. Much of this section is excerpted from the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS, which is incorporated by reference (BLM and MMS 2003). The focus is spilled oil, broadly defined to include crude oil, produced fluids, and refined products. Because the impacts are likely to be greater and more persistent from oil than from most other spilled materials (except possibly salt water), there are more data and analyses available, and most, though not all, stakeholders are generally more concerned about oil spills than about salt water or other chemical spills.

Salt water might behave generally like oil when it is spilled in large volumes, although salt water usually would be less viscous, especially in the warmer break-up and ice-free seasons, and could therefore spread farther than the same amount of oil might. If spilled into freshwater bodies, the salt water would be completely miscible and the salt concentration would be diluted in the fresh water. The amount of dilution depends primarily on the relative volume of the receiving water and the spilled salt water, as well as the dynamics of the receiving water body. For example, a spill into the Nigliq Channel at spring break-up flood stage might be diluted very rapidly, whereas a salt water spill to a small tundra lake on a calm summer day may remain at relatively high salinity for some time.

Materials such as methanol and ethylene glycol are completely miscible in water, and others, such as acids and some chemicals, are completely soluble in water. Because they are miscible or soluble, it is generally not practical to contain or clean up these materials before they are dispersed and diluted in the water or atmosphere. They may also be toxic until they are substantially diluted or neutralized.

---

[17] The "Other" category in the ADEC database includes 303 incidents of which at least 70 are described in explanatory notes as being partially or all salt water. Numerous spills of KCl solutions and other salt solutions are also included in the "Other" category. For this analysis, the incidents listed as "Other" are not assigned to one of the more specific categories in the ADEC database. Were this to be done, the details of some of the results presented herein might change but the general conclusions would not.

FACTORS AFFECTING THE FATE AND BEHAVIOR OF SPILLED OIL

The primary and shorter-term processes that affect the fate of spilled oil are spreading, evaporation, dispersion, dissolution, and emulsification (Payne et al. 1987, Boehm 1987, Boehm et al.1987, Lehr 2001, Leirvik et al. 2001). These processes are called weathering. Weathering dominates during the first few days to weeks of a spill. A number of longer-term processes also occur, including photo- and biodegradation, auto-oxidation, and sedimentation. These longer-term processes are more important in the later stages of weathering and usually determine the ultimate fate of the spilled oil.

The chemical and physical composition of oil changes with weathering. Some oils weather rapidly and undergo extensive changes in character, whereas others remain relatively unchanged over long periods of time. As a result of evaporation, the effects of weathering are generally rapid (one to a few days) for hydrocarbons with lower molecular weights (e.g., gasoline, aviation gas, and diesel). Degradation of the higher-weight fractions (e.g., crude oil, transmission and lube oil, hydraulic fluid) is slower and occurs primarily through microbial degradation and chemical oxidation. The weathering or fate of spilled oil depends on the oil properties and on environmental conditions, both of which can change over time.

Spreading

Spreading reduces the bulk quantity of oil present in the vicinity of the spill but increases the spatial area over which adverse effects could occur. Thus, oil in flowing systems (e.g., rivers and creeks, Harrison Bay) rather than contained systems (e.g., tundra ponds and lakes) would be less concentrated in any given location, but could cause impacts, albeit reduced in intensity, over a larger area. Spreading and thinning of spilled oil also increases the surface area of the slick, enhancing surface-dependent fate processes such as evaporation, bio- and photodegradation, and dissolution.

Evaporation

Evaporation is the primary mechanism for loss of low-molecular-weight constituents and light oil products. As lighter components evaporate, the remaining petroleum hydrocarbons become denser and more viscous. Evaporation tends to reduce oil toxicity but enhance persistence. Hydrocarbons that volatilize into the atmosphere are broken down by sunlight into smaller compounds. This process, referred to as photodegradation, occurs rapidly in air, and the rate of photodegradation decreases as molecular weight increases. Alpine crude oil from the current production field tends to have a greater proportion of constituents that evaporate rapidly compared to Endicott, Milne Point Unit, or North Star crude oils (Leirvik et al. 2001).

Dispersion

Dispersion of oil increases when water surface turbulence increases. Wind, gravity or tidal currents, or broken ice movement could cause the turbulence. The dispersion of oil into water increases the surface area of oil susceptible to dissolution and degradation processes and thereby limits the potential for physical impacts. However, some of the oil could become dispersed in the water column and/or on the bottom as it adheres to particulate matter suspended in the water column. The presence of particulates including organic matter, silt and clay, and larger sediment particles is likely to be greatest during break-up, flood flows, and wind storms (especially in Harrison Bay).

Dissolution

Dissolution[18] of oil in water is not the primary process controlling the fate of the oil in the environment; i.e., oil generally floats on rather than dissolves in water. However, to the extent dissolution does occur, it is one of the primary processes affecting the toxic effects of a spill, especially in confined water bodies. Dissolution increases with (1) decreasing hydrocarbon molecular weight, (2) increasing water temperature, (3) decreasing

---

[18] In this case, the definition of "dissolution" is to dissolve into water.

salinity, and (4) increasing concentration of dissolved organic matter. Components of gasoline (e.g., benzene, toluene, ethylbenzene, and xylenes) would dissolve more readily than the heavier fractions of crude oil or fuel oils under the same environmental conditions.

Emulsification

Emulsification is the incorporation of water into oil and is the opposite of dispersion. Small drops of water become surrounded by oil. External energy from wave or strong current action is needed to emulsify oil. In general, heavier oils emulsify more readily than lighter oils. The oil could remain in a slick, which could contain as much as 70 percent water by weight and could have a viscosity of a hundred to a thousand times greater than the original oil. Water-in-oil emulsions often are referred to as “mousse.”

Photodegradation

Photodegradation of oil increases with greater solar intensity. It can be a substantial factor controlling the disappearance of a slick, especially of lighter products and constituents, but it would be less important during cloudy days and could be nonexistent in winter months on the North Slope. Photodegraded petroleum product constituents tend to be more soluble and more toxic than parent compounds. Extensive photodegradation, like dissolution, could thus increase the biological impacts of a spill event.

Biodegradation

Biodegradation of oil by native microorganisms, in the immediate aftermath of a spill, would not tend to be a major process controlling the fate of oil in water bodies previously unexposed to oil. Although oil-degrading microbial populations are ubiquitous at low densities, including on the North Slope, a sufficiently large population must become established before biodegradation can proceed at any appreciable rate.

SUMMARY

Overall, the environmental fate of released oil is controlled by many factors, and persistence cannot be predicted with great accuracy. Major factors affecting the environmental fate include the type of product, spill volume, spill rate, temperature of the oil, terrain, receiving environment, time of year, and weather. Crude oil would weather differently than diesel or refined products in that both diesel and refined products would evaporate at a faster rate than crude oil. Most of the studies on North Slope crude oils have been done with Prudhoe Bay, Kuparuk or Endicott oil, which are heavier than Alpine crude oil (Leivrik et al. 2001). The Alpine crude oil may lose volatile fractions rapidly but still have a high enough pour point to flow under conditions in which the other three oils would not flow over the terrain.

The characteristics of the receiving environment, such as type of land, the surface gradient, marine or fresh water, spring ice overflow, summer open water, winter under ice, or winter broken ice, would affect how the spill behaves. In ice-covered waters, many of the same weathering processes are in effect as with open water; however, the ice changes the rates and relative importance of these processes (Payne et al. 1991).

The time of year when a spill occurs has a major effect on the fate of the crude oil. The time of year controls climatic factors such as temperature of the air, water, or soil; depth of snow cover; whether there is ice or open water; and the depth of the active layer. During winter, the air temperature can be so cold as to modify the viscosity of the oil so it would spread less and could even solidify. The lower the ambient temperature, the less crude oil evaporates. Both Prudhoe Bay and Endicott crudes have experimentally followed this pattern (Fingas 1996). Frozen ground would limit the depth of penetration of any spill.

FATE AND BEHAVIOR OF SPILLS ON TUNDRA

Movement of spills of oil and salt water over the ground surface follows the topography of the land. In general, a spill will flow until: (1) it reaches a surface water body or a depression, (2) infiltration into the vegetation cover, soil, and/or snow prevents further movement, or (3) increased viscosity due to low temperatures slows movement. Tundra relief on the coastal plain of the North Slope is low enough to limit the spread of spills. During summer, flat coastal tundra develops a dead-storage capacity averaging 0.5 to 2.3 inches deep (Miller et al. 1980), which can retain 12,600 to 63,000 gallons of oil per acre. Even at high water levels, the tundra vegetation tends to act as a boom, with both vegetation and peat functioning as sorbents that allow water to filter through, trapping the more viscous oil (for example, see Barsdate et al. 1980). On the other hand, even small spills can spread over large areas if the spill event includes aerial, pressured discharge. With the high-velocity, bi-directional winds on the North Slope, oil can be misted substantial distances downwind of a leak (BLM and MMS 2003). For example, in December 1993 an ARCO drill site line failed, and 40 to 160 gallons of crude oil misted over an estimated 100 to 145 acres (Ott 1997).

The rate of oil movement and depth of penetration into tundra depends on a variety of factors. If released onto dry tundra, oil can penetrate the soil because of the effects of gravity and capillary action until it encounters an impervious layer of water, ice, or tight soils. The rate of penetration depends on the season, temperature, soil saturation, nature of the soil, and the type of oil. In summer, spills may penetrate the active layer and then spread laterally on the frozen subsurface, accumulating in local depressions. From there, the oil may penetrate into the permafrost layer through cracks in the permafrost (Collins et al. 1993). Precipitation can increase dispersion over thawed soils (Chuvilin et al. 2001). Also in summer, there may be large areas of the tundra where there is a layer of standing water though not a pond or lake *per se*. In these areas, the oil would likely float on the water until it reaches dry ground or tundra vegetation including tussocks that are above the water and may become oiled. This vegetation may act as a barrier to further spreading of the oil.

Oil and some chemicals may effectively contact herbicides, which could result in barren patches of tundra potentially subject to thermokarsting.

In winter, the snow cover or frozen soil can slow the spreading of oil, depending upon the temperature of the oil, topographic relief, and the amount of snow cover. Snow cover may act as an absorbent, slowing the spread of oil and reducing the amount of the spill that reaches the tundra surface. During winter, oil may spread on the surface of the frozen soil, and penetration of oil into the soil is generally limited. However, pore space in the soils that is not filled with ice may allow spilled oil to move into the frozen soil (Yershov et al. 1997, Chuvilin et al. 2001).

Salt water spills on tundra generally behave similar to oil spills. The primary difference is that salt water may freeze at temperatures just below freezing, depending upon the discharge temperature and overall salinity of the salt water. Freezing can prevent the salt water from spreading very far, especially in winter. However, in the summer, salt water is much less likely to freeze and it may flow farther through the vegetation than would the same volume of oil. The salt water also is more likely to penetrate farther into the soil and the permafrost to the extent that there are voids in the permafrost. Finally, the salts in salt water do not weather as oil does and these salts would likely persist until they are diluted and/or transported from the area by freshwater flows from precipitation, floods, or flushing activities of the cleanup and restoration crews.

FATE AND BEHAVIOR OF SPILLS INTO MARINE OR FRESH WATER

Weathering processes generally would be similar in fresh water and coastal marine regimes in the Plan Area. Seasonal ice cover could greatly slow weathering in both regimes.

Oil spreading on the water surface (but not necessarily the transport of oil by moving water) would be restricted in most Plan Area waters. Because of the increased viscosity of oil in cold water, oil spills in Plan Area lakes, rivers, and marine waters would spread less than in temperate fresh or marine waters. The exception to this would be a spill in shallow, marshy, or ponded tundra or flooded lake margins in summer, which could spread similarly to a temperate spill. The exception is possible because these shallower waters are often warmer than other tundra waters (Miller et al. 1980) and warm enough to lower oil-slick viscosity.

An oil spill in broken ice in the Nigliq Channel or Harrison Bay would spread less than on an open lake and would spread between ice floes into any gaps greater than approximately 4 to 6 inches (Free et al. 1982). An oil spill under ice in lakes, rivers, or Harrison Bay would follow the general course described below:

- The oil would rise to the under-ice surface and spread laterally, accumulating in the under-ice cavities (Glaeser and Vance 1971, NORCOR 1975, Martin 1979, Comfort et al. 1983).
- For spills that occur when the ice sheet is still growing, the pooled oil would be encapsulated in the growing ice sheet (NORCOR 1975, Keevil and Ramseier 1975, Buist and Dickens 1983, Comfort et al. 1983).
- In the spring, as the ice begins to deteriorate, the encapsulated oil would rise to the surface through brine channels, stress cracks, and pressure ridges in the sea ice or water channels in lake ice (NORCOR 1975, Purves 1978, Martin 1979, Kisil 1981, Dickins and Buist 1981, Comfort et al. 1983) or by ablation of the surface layers of ice. If the ice breaks-up before the oil is exposed, then the oil would be transported downcurrent or downwind in the broken ice and could be widely distributed along the creek and riverbanks, in the Colville River Delta, and possibly even as far as Harrison Bay.

The presence of currents could affect the spread of oil under the ice if the magnitude of those currents is large enough. A field study near Cape Parry in the Northwest Territories reported currents up to 0.2 knots. This current was insufficient to move oil from under the ice sheet after the oil had ceased to spread (NORCOR 1975). Laboratory tests have shown that currents in excess of 0.3 to 0.5 knots are required to move oil collected in under-ice depressions (Cammaert 1980). Current speeds in the nearshore Beaufort Sea, including Harrison Bay, generally are less than 0.2 knots during the winter (Weingartner and Okkonen 2001). The area of contamination for oil under ice could increase if the ice were to move. For example, because the nearshore Beaufort Sea, including Harrison Bay, is in the landfast ice area, the spread of oil from ice movement would not be anticipated until spring break-up; however, once break-up occurs the oil could be moved long distances rapidly.

The weathering processes that act on oil in and along a river or stream are similar in most cases to those for marine spills. The dynamics of a river or stream environment, however, have additional effects on the fate and behavior of spilled oil. Oil entering a river begins to spread in the same manner as in the marine environment, but the spreading motion would be overcome rapidly by the surface current at which point an elongated slick would form. The oil would flow downstream at the speed of the surface current. As the surface current speed increases with channel constriction and decreases with channel widening, the oil movement rate also would increase and decrease as the slick alternately passes through constricted meander bends and wider, straight channel sections. The effect of wind would slow or accelerate the downstream movement if the wind direction parallels that of the channel. With the sinuous character of most North Slope rivers, this could lead to alternate slowing and acceleration as the oil slick moves downstream. A second effect of wind would be to move the oil toward the downwind riverbank, contributing to the stranding of oil. Water near the center of a stream channel generally would flow faster than water near the banks or bottom of the channel where the retarding forces of friction with the channel are greater. This difference in current speed and the resulting shearing forces between water layers is typically the major mixing mechanism that causes a slick to spread as it moves downstream. The resulting spread of the oil along the axis of flow controls the plume shape and size, and the distance over which the oil concentration would remain above a particular level of concern. The leading edge of the slick could move as a relatively sharp front (at the current speed in the middle of the channel); however, mixing would continuously exchange water and oil between the slower, near-bank regions and the faster-flowing, center regions of the river. From a practical point of view, this means that, although it would be possible to predict the initial arrival of oil at a point along the river, it would be considerably more difficult to estimate when the threat is past, because the areas of slower currents could continue to supply oil to the main stream channel, even after the leading edge is past (BLM and MMS 2003).

Stream flow is unidirectional in a long, straight channel; however, few natural channels in this region are straight and uniform for more than a few hundred yards. As water flows around a bend in a river or encounters an eddy, centrifugal force tends to pile water up along the outside edge of the turn. This secondary flow slightly deflects the streamlines in the flow as the river moves around bends. More importantly, secondary flow helps move oil particles across the shear boundaries and greatly increases the spreading, or dispersion, of the slick in the downstream direction. Thus, oils tend to spread more rapidly, decreasing their peak concentrations relative to what would be expected for a straight channel (BLM and MMS 2003). Shear-dominated flows cause another effect that characterizes river spills. Shear in currents along the banks and river bottom are typically the major source of turbulence in rivers, in contrast to surface-wave activity in oceans. Mixing and dispersion caused by the interaction of the shear and the turbulence can move substantial amounts of oil below the surface (particularly if it is relatively dense, such as a heavy fuel or crude oil, or if it is finely distributed as droplets). The shear-dominated river regimes tend to produce spill distributions having higher subsurface oil concentrations than would be expected in marine spills (BLM and MMS 2003). This turbulence increases with increased velocity of flow and bed roughness. In faster flowing conditions, the geographic spread and the affected area could be greater than under slower flow conditions, although local concentrations of oil could be greater for slower streams.

The rate of movement of the leading edge of oil spilled into a river could be virtually the same as the maximum surface current in the river. Near-surface current velocities in the range of one to two knots have been measured in the Ublutuoch River, which could result in oil moving downriver approximately 30 to 60 miles per day (PAI 2002a, PAI 2002d, CPAI 2003p). These values provide an estimate for the speed at which the leading edge of a surface oil slick could travel downstream.

For any oil that enters a river, irrespective of flow velocities or water levels, some of the oil would end up on the riverbanks or in flood flows, even on the tundra, and in normally isolated tundra ponds. The most common riverbank substrate material in the Plan Area is sand, and the most common bank forms are sand point bars or channel margin bars and sand- or peat-eroding cut banks. It is not practical to predict or estimate how much oil per unit area would be stranded on a riverbank or reach as this depends on the following factors:

- Physical character of the oil, which would change as the spilled oil weathers
- Physical character of the riverbank material, such as sand, grass, peat, etc., which would vary considerably even over short distances
- Speed at which the water would flow at the water-sediment interface
- Size of any wind-generated waves on the river surface that would spread the oil over a band above the water level
- Changes in the water level and flow volume through the time that oil would pass through a reach; these changes would depend upon both season and recent/ongoing storm events
- Direction, persistence, and magnitude of winds occurring during and after the oil spill event; strong persistent winds could strand oil against lee banks and/or create surface currents that could be stronger than the instream, near-surface velocities would otherwise be

As a general guide, if one assumes that stranded oil would be uniformly 0.4 inch thick and evenly covered a band 6 inches wide, then 42 gallons of stranded oil would cover 35,000 feet or 6.5 miles of riverbank or 3.25 river miles if the riverbanks on both sides were coated equally. For example, in this scenario, 42 gallons of stranded oil from a spill at the Ublutuoch River crossing would oil both banks more than half way to the mouth of the river where it flows into Fish Creek.

The point bars and channel margin bars are dynamic features, and the sand is constantly redistributed by water action so that stranded oil could be eroded, typically, on upstream sections of a bar, or buried on the downstream sections of a bar. Cut banks are erosion features so that oil stranded on an active face would not persist and could be remobilized in a matter of minutes or hours if active bank erosion were occurring. If the water level drops and oil is stranded above the water line, erosion at the base of the bank could cause slumping and re-entrainment of the oil in the river. Oil could typically persist in the following areas:

- Stable vegetated banks where the oil could coat branches, leaves, and grass
- Ponds or channels where the oil is left above the level of the river by falling water levels
- Areas of quiet water or eddies at the inside of river bends on a meandering channel
- Other pools or backwaters where velocities are slower.

4.3.3 SUMMARY OF IMPACTS TO RESOURCES FROM VERY SMALL TO LARGE SPILLS

4.3.3.1 Overview

This section focuses on the potential impacts to each of the resource categories resulting from very small spills (less than 10 gallons and mostly less than one gallon) to large spills (1,000 to 100,000 gallons) (Section 4.3.2.3). Very large spills (greater than 100,000 gallons) are considered in more detail in Section 4.3.4.

The impact assessment is based on the past 30 years of North Slope experience. The vast majority of spills have been very small or small, contained within the boundaries of the secondary containment or at least on the gravel pads and roadways, cleaned up expeditiously, and resulted in impacts to the natural resources of the North Slope that are limited in area, duration, and size. However, large spills have occurred or could occur, albeit with low probability, and the impacts of those are included here.

This section summarizes impacts by resource category for Alternative A – CPAI Development Plan and draws heavily upon and incorporates by reference the impact assessments from the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003), as well as information in other recent North Slope EISs (BLM and MMS 2002, BLM and MMS 1998b, TAPS Owners 2001a). Substantial differences in Alternatives B, C-1, C-2, D-1, D-2, and F are then described. To reduce redundancy, there is no repeat of each of the resource-specific impact assessments where they are essentially the same in Alternatives B, C-1, C-2, D-1, D-2, and F as those in Alternative A. Alternative E is the no-action alternative and would not result in any spill-related impacts from the ASDP development.

This section also evaluates the potential impacts of FFD on each resource category in Alternative A. For many of the resources (for example, paleontological, soils, air, economy, visual, and recreational), the impacts would be essentially the same as those for the CPAI Development Plan and, to reduce redundancy, the appropriate descriptions are referenced. For others (for example, fish, spectacled eiders, marine mammals, subsistence use of caribou) where the location of production pads and/or processing facilities result in potential spills affecting resources that the CPAI Development Plan might not, an assessment of potential impacts of the FFD is provided.

4.3.3.2 Spill Scenarios

A range of spill scenarios is provided to facilitate the impact assessment.

VERY SMALL (LESS THAN 10 GALLONS) AND SMALL (10 - 99.5 GALLONS) SPILLS

The most common scenarios are the very small spills and small spills of material, usually diesel, hydraulic fluid, transmission oil, and antifreeze, on gravel pads, roads, and airstrips, or on ice roads and pads. Rarely do these spilled materials reach the tundra or water bodies. When they do, they usually impact the area adjacent to the road or pad and are limited in the area they affect. However, some of these small spills are from salt water, oil, or produced fluids lines, and they could occur on the tundra or into water bodies remote from the roads and pads.

MEDIUM (100 – 999.5 GALLONS) AND LARGE (1,000 TO 100,000 GALLON) SPILLS

A similar scenario exists for medium-to-large spills except they are much less common and they do occasionally reach the tundra or water bodies adjacent to the roads, pads, and airstrips. These spills are more likely to be of salt water, oil, or produced fluids, although medium to large spills of antifreeze, diesel, and drilling muds may occur.

PIPELINE SPILLS

Pipeline spills are likely to reach tundra and/or adjacent water bodies, especially if they are large and occur in the ice-free seasons. The medium to large pipeline spill scenarios could result in impacts to creeks or rivers, as well as to the tundra. The main features of these scenarios are provided in Table 4.3.3-1. These scenarios were selected as reasonable worst-case incidents in terms of the largest volume that might be spilled to the water body or tundra, and of the diversity and sensitivity of environmental resources that might be impacted. The first four scenarios in Table 4.3.3-1 are guillotine ruptures of the pipelines crossing a major creek or river. The actual volumes spilled could vary depending upon location and activation methods and times for valves or vertical loops, pressure in the line, actual location of the break, and other factors; however, the type and magnitude of potential impacts is likely to be similar over the potential range of spill volumes. The fifth scenario in Table 4.3.3-1 is from a pipeline to the tundra. The spill scenario is a proxy for substantial spill to the tundra of produced fluids, salt water, and, in the FFD, Sales Oil. The actual length of line that drains after rupture could vary substantially, usually being shorter than the estimated 7.8 miles between CD-7 and CD-6. Also, to the extent the pipelines follow the topographic contours and there are low spots in the pipelines (or vertical loops or valves), the amount of oil that spills could be much smaller. However, until the final alignments are determined and the pipelines constructed, the largest and most likely potential spill volumes cannot be estimated precisely or accurately.

TABLE 4.3.3-1 POTENTIAL PIPELINE SPILL VOLUMES

		Produced 3-Phase Fluids		Salt water[e]		Diesel		Sales Oil (FFD only)	
Pipeline Segments	**Length (ft)**	**Size (in)[g]**	**Vol (gal)[a]**	**Size (in)**	**Vol (gal)**	**Size (in)**	**Vol (gal)**	**Size (in)**	**Vol (gal)**
Nigliq Channel	2500[b]	24	11,750	14	19,992	–	–	14	23,100
Ublutuoch River	2500[f]	24	11,750	14	19,992	–	–		
CD-1-CD3	34,054	18	86,688	10	127,470[c]	2	5,558		
CD-22-CD6 (Fish Creek in FFD only)	55,864	24	141,666	14	446,732				
CD7-CD6 (Tundra crossing)[d]	41,184	24	193,571	14	329,340	–	–	14	329,340

Notes:

[a] Assumes that the produced fluids are approximately 20 percent liquid, consisting of oil and brine in some currently unspecified proportion that could be deposited on the surface.

[b] Length of segment that would drain

[c] Based on CPAI response to ENTRIX request for information (Shifflet 2003)

[d] Assumes no valves between pads and the entire segment could drain. Topographic relief as well as location of valves and/or vertical loops for the final pipeline route could result in substantially smaller spill volumes.

[e] Static volume assuming entire length of line drains and valves at the ends of the segment stops flow immediately.

[f] Based on the assumption that all major river/creek crossings would have valves or vertical loops approximately 2,500 feet apart on either side of the river.

[g] Pipeline size is inches in diameter.

PROXIMITY OF PADS AND PROCESSING FACILITIES TO MAJOR STREAMS AND RIVERS

The proximity of pads and processing facilities to major streams and rivers from which medium to very large spills of produced fluids, oil, and salt water, as well as diesel and other materials in bulk storage tanks and containers could occur may be an important factor in the impact scenarios. In general, if the spilled material flows to the tundra, the material would probably not disperse very far. However, if a medium- to-large (or very large) spill reaches a flowing creek or river, the material could be dispersed for substantial distances downstream. In flood flows, the material also could be distributed over the flooded tundra, and into tundra ponds and lakes. As shown in Table 2.3.11-2, most of the pads and hypothetical processing facilities are greater than 0.5 miles from the nearest major river or stream. Whether a spill would reach these rivers or streams would depend upon several variables including the type, temperature, and volume of material spilled, the topographic relief and slope, air temperature, presence of snow and/or vegetation, and response time and actions.

RESOURCE-SPECIFIC IMPACT ASSESSMENT

Soils

Spills that are not confined to ice or gravel pads and roads could affect the soils, especially where there is little to no vegetation or snow cover to provide a barrier and “sorbent” for the spilled material. Crude oil in the produced fluids and Sales Oil (FFD only), lubricating oil, and similar heavy oils would be less likely to reach the surface soil layers than would refined oil (for example, diesel), which could infiltrate through the vegetation. Salt water is likely to reach the soil especially in the warmer snow-free seasons because its low viscosity would allow it to penetrate the vegetation and even thin snow layers. The depth of penetration of oil into the soil would depend on the porosity of the soil and the extent to which it is frozen or saturated with liquid water. The area affected would be limited to that area immediately adjacent to and covered by the spill.

Spills could affect soils indirectly by affecting the vegetation, which in turn could die and expose the soil to thermokarsting, wind erosion, etc., even if the soil itself were not directly affected by the spilled material.

Spill cleanup is more likely to affect the soils than the presence of the spilled material itself unless the cleanup is well controlled and heavy traffic and digging are minimized (especially for summer spills). Spill cleanup mitigates impacts on soils only if cleanup methods and operations are very carefully controlled and minimize surface disturbance.

Spilled salt water would be likely to infiltrate to and into the surface soil layers, even if there is vegetation or snow cover. Depending on the porosity of the soil and the extent to which the pore spaces are filled with ice, the salt water could penetrate to or below the tundra vegetation root zone. In locations such as the outer regions of the Nigliq Channel and Colville River Delta, as well as the estuarine region of Fish Creek, where the vegetation includes halophytic (salt-tolerant) plants, the impacts of salt water spills could be of smaller magnitude and duration than in most of the rest of the tundra where the plants are non-halophytes. The soils affected by salt water spills could take as little as one year and possibly up to several years to return to normal, depending on the initial salinity of the salt water and the amount of flushing from precipitation and flooding (McKendrick 2000, 2001).

This impact assessment also applies to the FFD for the Plan Area. Salt water spills could have a lesser impact on the soils supporting halophytic plants in the estuarine reaches of the Kogru River and Kalikpik River because (1) the halophytic plants are salt tolerant, and (2) all but a large to very large salt water spill are likely to be substantially diluted with the Kalikpik River freshwater flow by the time the spilled salt water reaches the estuary located several miles downstream from the hypothetical pipeline crossing.

Paleontological Resources

Most spills are confined to a pad or roadway or to an area adjacent to them. The primary exceptions are spills from pipelines to tundra, remote from the roads and pads. In the construction stage, most spills would occur on an ice pad or ice road during winter conditions, where snow and ice would limit impacts to paleontological resources and cleanup is less invasive than in a summertime terrestrial spill. In any case, paleontological resources usually are so deeply buried that they probably would not be affected by either a spill or subsequent spill cleanup. The effects of spills and spill cleanup associated with drilling and production would be similar to those associated with construction activities except that they could occur during the snow-free months. Although cleanup from these spills might be more invasive because of the non-frozen surface environment, there is little chance that subsurface paleontological resources would be affected. If present, surface paleontological remains could be affected in the same manner as surface cultural material. However, because the occurrence of surface paleontological remains is rare and, where known, would be avoided by plan facilities, the probability of any impact is remote.

This impact assessment also applies to the FFD for the Plan Area.

Water Resources

In the unlikely event that spilled material flows to or is deposited on the water bodies near the pads and/or leaks from a pipeline, it could affect the water resource value of that water body. The primary resource use of water bodies, other than as habitat for wildlife and fish, is to support the oilfield activities. A key use is water from the Permitted Lakes (see Figure 2.4.1.1-11). In the CPAI Development Plan, there is a potential for a medium to large spill from pipelines or from a vehicle or equipment on roads to reach these lakes between CD-7 and CD-6 in Alternatives A, B, C and F. In Alternative D (the roadless alternative) and for CD-3 in Alternatives A, B, and F (which is also roadless), the likely potential source would be only from pipelines.

If the spilled material is oil, cleanup actions could adversely affect water resources until the petroleum residue weathers or could be flushed from streams. This process could take a few weeks in a fast-flowing stream to a decade or longer in lakes and ponds.

Spills of most of the chemicals used in the oil fields and salt water generally would be rapidly diluted and have little impact in a large lake or river. In small lakes, tundra ponds, and shallow water tracks, the impacts could be greater, with waters potentially remaining toxic to sensitive species for up to a few years. These spills could be pumped out of the water body, if confined, or neutralized, and then diluted with uncontaminated fresh water.

This impact assessment also applies to the FFD for the Plan Area. In the FFD, additional Permitted Lakes near HP-16 and HPF-1, near the road between HP-2 and HP-10, and near the pipeline and road between CD-5 and Nuiqsut could also be affected.

Surface Water Quality (Fresh Water)

Spills could affect freshwater quality if the spilled material reaches water bodies either directly or from flowing over the tundra. However, the vast majority of all spills are confined to a pad, road, or airstrip, to an adjacent area, or to the area under a pipeline. Most spills are very small to medium in volume (i.e., fewer than 1,000 gallons). In addition, for two-thirds of the year, spill response could remove almost all of an oil, chemical, or drilling mud spill from frozen tundra or ice-covered water bodies prior to snowmelt. During one-third of the year (late May through late September), spills could reach and affect wet tundra and tundra ponds and lakes, as well as creeks and rivers before spill response is initiated or completed.

If the spilled material, especially petroleum hydrocarbons and other organics, would reach the freshwater bodies, there could be an impact to water quality in reduced dissolved oxygen concentrations and increased toxicity to aquatic organisms.

Dissolved-oxygen concentrations in tundra waters could be affected by spilled oil in summer. The National Petroleum Reserve-Alaska experiment provides an illustration of the potential impacts (Miller et al. 1978, Barsdate et al. 1980, Hobbie 1980). In summary, 210 gallons of Prudhoe Bay crude were spilled into a 0.07-acre tundra pond. Dissolved-oxygen concentrations a week after the spill were reduced by approximately 4 milligrams per liter (mg/l) below levels in a control pond, and some measurements within inches of the surface, just under the slick, were less than 5 mg/l (state standard for protection of wildlife). At the 4-inch water depth (average pond depth, [Miller et al. 1980]), outside the slick, oxygen concentration was within the expected normal range of 10.8 mg/l versus 11.4 mg/l in the control pond. The oxygen deficit under the slick (and also in the shallower waters of the control pond) was attributable to decreased oxygen influx from the air because of the relative impermeability of the oil slick to oxygen and to the relatively high rate of natural sediment respiration in coastal tundra ponds. The oxygen deficit was not attributable to oil-enhanced respiration of oil-biodegrading microorganisms in the pond.

In winter, even under ice, an oxygen deficit would not be expected to result from a small spill in most waters because low biological abundance and activity means that sediment and water column respiration rates are low to negligible. In addition, sediment respiration has even less relative effect in the thicker water column of lakes deep enough not to freeze solid in winter. Such lakes, even those that hold fish, tend to be supersaturated with dissolved oxygen in winter, to levels above the state water-quality standard of 110 percent saturation (BLM and MMS 1998). An exception might be if a spill were to occur underneath thick ice cover in very restricted waters holding a concentrated population of overwintering fish that already have depleted oxygen levels. These low oxygen concentrations could occur in the deeper pools of the Colville River, Nigliq Channel, and several of the other rivers and creeks in the Plan Area.

During open water periods in the Colville River Delta, Nigliq Channel, Ublutuoch River, and, for the FFD, in Fish-Judy Creeks, and Kogru River, there would be no detectable impacts on dissolved oxygen levels due to the spilled materials. The relatively high river volume (relative to the volume of oil) and the high rate of water flow would dilute the oil before there were any effects on dissolved oxygen concentrations.

The primary effect of a very small to large oil spill would be from direct toxicity to aquatic plants and animals. Long-term toxicity (up to a decade) can result from a small spill, as shown in the National Petroleum Reserve-Alaska experimental pond spill (Miller et al. 1978, Barsdate et al. 1980, Hobbie 1982). In a real oil spill, containment and cleanup response likely would recover the bulk of spilled oil, but sufficient oil could remain trapped in the sediments and/or aquatic vegetation to promote long-term, low-level toxicity on a local basis. Long-term toxicity would be less likely to occur in larger lakes and creeks or rivers because the oil would be diluted and/or dispersed with the sediment over large areas by currents and wind/wave action. Spills into the larger rivers and creeks (e.g., Colville River Delta, Nigliq Channel, Ublutuoch River, and, for the FFD, in Fish-Judy Creeks and Kogru River), especially during open water periods, might have toxicity impacts limited to the first few reservoir pools downcurrent of where the spill entered the river because of the large and rapid dilution of the oil relative to the flow volumes. In the smaller flowing creeks, the lower relative volume and rate of water flow could have direct toxicity impacts in the water column and sediments. Some toxicity might persist in these creeks for a few weeks to years, until toxic compounds were washed out of the oil trapped in the sediment or the oiled sediment was buried under cleaner sediment.

An oil spill reaching the larger tundra lakes (e.g., Nanuk Lake; see Figure 2.4.1.1-11) would result in a minimal effect on water quality. Dissolved oxygen levels would not be affected. Direct toxicity would be minimal because of the much greater dilution volume in these lakes than in the small ponds and lakes. The spreading of the spill over the lake surface could be considered an effect on water quality. This effect would exist for a few weeks, until either the slick was cleaned up or the oil stranded on the shoreline.

There are likely to be fewer spills that would affect freshwater bodies in Alternative D than in Alternatives A through C and F because much less vehicle and heavy equipment traffic would occur in the ice-free season when the freshwater bodies are most vulnerable. There would be more winter traffic and thus a greater chance of bulk container spills in Alternative D, but the spills are likely to be cleaned up quickly.

A salt water spill to smaller freshwater bodies could exceed state freshwater quality standards (State of Alaska, ADEC 1997), which prohibit total dissolved solids or salinity from exceeding 1.5 percent salinity. The treated seawater from Kuparuk Seawater Treatment Plant is approximately 3.3 percent much of the year and the brine in the produced fluids is likely to be approximately 2 percent (CPAI 2003q). In a year with high rainfall, some of the salt would be diluted and flushed from the tundra ponds and lakes during summer. Some of the seawater could settle into the deepest reaches of the contaminated waters. The freeze/thaw cycle in the Arctic and the depth of any lake reached by the spill would play a controlling role in the fate of the remaining contaminating salts from a spill (Hobbie 1984, Prentki et al. 1980, Miller et al. 1980, O'Brien et al. 1995).

This impact assessment also applies to the FFD for the Plan Area.

Marine Water Quality

Under any of the CPAI Development Plan alternatives, very small to medium spills (i.e., up to 1,000 gallons) of oil or other hazardous materials are unlikely to reach marine waters of Harrison Bay or the nearshore Beaufort

Sea in measurable amounts. Even if these spills reach the flowing waters of the creeks and rivers, the volume of the spilled material would be diluted before it is discharged to the marine waters where it would be further diluted rapidly to very low concentrations approaching ambient conditions. No facilities or pipelines are proposed on or immediately adjacent to the marine coastal zone and, with exception of HP-22, HP-5, HP-13, and HP-14 in the FFD, the sources of spilled material are generally far enough from marine waters that, by the time spilled material reaches the marine waters, the spilled material would have very little impact to marine water quality or resources.

If a medium to large spill enters a river resulting from an undetected slow leak, the oil could be transported over the landfast ice in the marine environment during break-up before the oil could be cleaned up. The transport of the oil along with ice and fresh water would occur during the break-up floods. The flood flow volumes would dilute the oil and disperse it over a large area of the landfast sea ice where it would be further diluted as it mixes with the marine water and flood waters. The dilution factor is likely to be great enough that the oil would be essentially undetectable in the marine waters.

Any spill of salt water that is eventually transported to the marine environment would have no impact on the marine water quality of organisms. The salt water is near to ambient salinity so that even if it could be discharged directly to the marine waters (no sources are proposed in the CPAI Development Plan or the FFD that are likely to result in this), the spilled salt water would rapidly be diluted to ambient salinity.

Estuarine Water Quality

Most spills are very small to small and would not leave the pads, roads, airstrips, or other facilities, so they would not affect estuarine water quality or resources. Spills (primarily medium to large) from pipelines directly into rivers and creeks flowing to the Nigliq Channel, Colville River Delta, and/or Harrison Bay or lower Kogru River, could affect estuarine water quality at the mouths of these rivers and could measurably degrade estuarine water quality and shorelines of the Plan Area. On some shoreline types (see Figures 3.2.1.1-2 and 3.2.1.1-3), spilled oil could persist for several years, and possibly for more than a decade. On other shorelines, especially high energy, eroding ones, the stranded oil would likely not persist for more than a few months to a couple of years.

If a medium to large oil spill were to occur during the open water or broken-ice seasons from the pipeline between CD-1 and CD-3, especially where the pipeline crosses the channels in the Colville River Delta, or from the CD-3 pad, the oil could reach the estuarine waters of the Colville River Delta and lower Harrison Bay. This oil could be dispersed over and dissolved in the water column and could be incorporated into the sediments (BLM and MMS 2002). The oil could measurably degrade estuarine water quality and contaminate shorelines, in spite of proposed spill responses. The Liberty EIS (MMS 2000b) concluded that hydrocarbons dispersed in the water column from a medium to large (greater than or equal to 21,000 gallon) oil spill could exceed the 1.5-ppm acute toxicity criterion during the first day in the immediate vicinity of the spill (BLM and MMS 2002). Further, the hydrocarbon concentration could exceed the 0.015-ppm chronic criterion for up to 30 days in an area that ranges up to 70 square miles, which would include the size of most of the estuarine habitats in the Plan Area.

This impact assessment also applies to the FFD for the Plan Area. In the FFD, additional estuarine habitats that might be affected include the mouths of Fish and Judy Creeks, Kalikpik and Kogru Rivers, and the northeastern Colville River Delta near HP-4, HP-7, HP-12, HP-13, and HP-14.

Air Quality

Based upon modeling work by Hanna and Drivas (1993), the majority of volatile organic compounds (VOCs) from crude oil spills likely would evaporate almost completely within a few hours after the spill occurred, especially during the late spring-early fall when most of the biological resources are present on the North Slope. Emissions of VOCs, such as benzene, ethylbenzene, xylene, and toluene, would peak within the first several hours after the spill starts and drop by two orders of magnitude after approximately 12 hours. The heavier compounds take longer to evaporate, particularly at the colder temperatures typical of the Plan Area, and might not peak until more than 24 hours after the spill. In the event of an oil spill on land in the National Petroleum

Reserve-Alaska, the air quality effects would be less severe than on water because some of the oil could be absorbed by vegetation or into the ground. However, some effects might last longer before the VOC compounds completely dissipated.

Diesel fuel oil could be spilled during refueling, from a broken diesel pipeline, or from accidents involving vehicles or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient hydrocarbon concentrations would be higher than with a crude oil spill, but would also persist for a shorter time. Also, since any such spill would probably be smaller than potential crude oil spills, any air quality effects from a diesel spill likely would be even lower than for other spills.

There would be no air quality impacts associated with salt water spills.

The air quality impacts of oil spills would be localized and short term. The associated VOC air emissions would have little impact on the biological or physical resources of the Plan Area in either the CPAI Development Plan or the FFD.

Vegetation

Most spills will occur on ice or gravel pads, roads, and airstrips, and the spilled material will not leave the facility. Consequently, their effects would not reach and would have no impact on the vegetation. However, some of the medium to large spills could reach the adjacent tundra vegetation by (1) directly flowing from the facility, (2) depositing from aerial dispersal of fluids from a pressurized pipeline leak, or (3) spilling from a pipeline over the tundra.

Furthermore, approximately two thirds of the year, there is sufficient snow cover to slow the flow of spilled material and to allow spill cleanup efforts to occur before spilled materials spread substantial distances from the spill source. Thus, there would be a limited impact to vegetation from these spilled materials. However, there might be an impact from the cleanup operations if they are not implemented carefully and with regard for minimal disturbance of the surface soils and vegetation. During the other third of the year, there is less snow cover and the spilled materials may flow further on the tundra depending upon topographic relief, temperature, material spilled, and vegetation type, density and height.

Most oil spills would cover less than an acre but potentially up to several acres if the spill were a windblown mist. Overall, past spills on Alaska's North Slope have caused minor ecological damage, and ecosystems have shown a good potential for recovery with wetter areas recovering more quickly (Jorgenson and Martin 1997, McKendrick 2000b). Oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants and sometimes kill all macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years, if the site is not rehabilitated (McKendrick and Mitchell 1978). The length of time a spill persists depends upon soil moisture and the concentration of the product spilled. McKendrick (2000b) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. A dry habitat exposed to the same application supported less than 5 percent vegetative cover after 24 years. For the most part, tundra oil spills would be very local (less than one acre) in their effects and would not be expected to contaminate or alter the quality of habitat outside this limited area. However, some local contamination of tundra vegetation is expected to occur near production wells and processing facilities. Spills that occur within or near streams and lakes could affect foraging habitat along these water bodies.

A spill of salt water has the potential to affect vegetation. The size of the area affected would depend on the terrain and land cover at the spill site and would be proportional to the amount of salt water spilled. If such a spill were to occur within a community of halophytic plant species, there could be little effect. Otherwise, depending on the specific situation under which the spill occurred, the result could vary from little impact to total plant death in the area affected, with eventual replacement of the vegetation community by halophytic species. According to McKendrick (1999b, 2000b), brine (and other salt water) spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have adverse effects on salt-intolerant vegetation near the salt water pipeline, but the amount of tundra habitat affected would be small, no more than a few acres. Thus, potential salt water spills are not likely to affect forage availability for terrestrial mammals in the Plan Area.

The potential impacts to vegetation could be less in Alternative D (roadless) than for Alternatives A through C and F because there would be less risk of oil spills in Alternative D from vehicle and heavy equipment accidents during the ice/snow-free season. The increase in vehicle and equipment, as well as bulk fuel transport in winter in Alternative D, could result in more spills on ice roads and pads, but the spilled material would be contained by and cleaned up from the snow and ice before it could contact the vegetation.

This impact assessment also applies to the FFD for the Plan Area.

Freshwater and Anadromous/Amphidromous Fish

Spills could affect freshwater and anadromous/amphidromous fish while they are in fresh water (hereafter called freshwater fish in this section), if the spilled material reaches fish habitats either directly or from flowing over the tundra. However, the vast majority of all spills are confined to a pad, road, or airstrip, to an adjacent area, or to the tundra area under a pipeline. Most spills are very small to medium in volume (i.e., less than 1,000 gallons). Finally, spill response would remove almost all of an oil, chemical, or drilling mud spill from frozen tundra or ice-covered water bodies prior to snowmelt for two-thirds of the year. During one-third of the year (late May through late September), spills could reach and affect tundra ponds and lakes, as well as creeks and rivers, before spill response is initiated or completed.

The effects of oil spills on freshwater fish have been discussed in previous Beaufort Sea EISs (e.g., BLM and MMS 2002, USACE 1999), which are incorporated here by reference and summarized. Oil spills have been observed to have a range of effects on North Slope fish. (For more detailed discussions, see Starr et al. 1981, Hamilton et al. 1979, and Malins 1977.) The specific effect depends on the concentration of petroleum present, the length of exposure, and the stage of fish development involved (larvae and juveniles are generally most sensitive). If lethal concentrations are encountered (or sub-lethal concentrations over a long enough period), fish mortality might occur. However, mortality caused by a petroleum-related spill is seldom observed except in small, enclosed water bodies and in the laboratory environment. Most acute-toxicity values (96-hour lethal concentration for 50 percent of test organisms [LC50]) for fish are generally from 1 to 10 ppm of the toxic hydrocarbons. Concentrations observed under the oil slick of oil spills have been less than the acute values for fish and plankton. For example, extensive sampling following the Exxon Valdez oil spill (approximately 11,000,000 gallons in size) revealed that hydrocarbon levels were well below those known to be toxic or to cause sub-lethal effects in fish and plankton (Neff 1991). The low concentration of hydrocarbons in the water column following even a large oil spill appears to be the primary reason for the lack of lethal effects on fish and plankton. The concentration in flowing rivers and creeks of the Plan Area also would be relatively low, even for medium to large oil spills.

However, if an oil spill of sufficient size were to occur in a small body of water with restricted water exchange (e.g., tundra ponds, small slow-flowing creeks) and containing fish, lethal and sub-lethal effects could occur for the fish and food resources in that water body. Toxic concentrations of oil in a confined area would have greater lethal impacts on larval fish versus adults. McKim (1977) reviewed results from 56 toxicity tests and found that, in most instances, larval and juvenile stages were more sensitive than adults or eggs. Increased mortality of larval fish is expected because they are relatively immobile and are often found at the water's surface where contact with oil is most likely. Adult fish would be able to avoid contact with oiled waters during a spill in the open water season but survival would be expected to decrease if oil were to reach an isolated pool of ice-covered water.

An example of the impacts to fish food resources is provided by Barsdate et al. (1980), who studied the limnology of an arctic pond near Barrow with no outlet, after an experimental oil spill. They found that half of the oil was lost during the first year. The remaining oil was trapped along the edge of the pond; most of it sank to the bottom by the end of summer. Researchers found no change in pH, alkalinity, or nutrient concentrations. Photosynthesis was briefly reduced and then returned to normal levels after several months. *Carex aquatilis*, a vascular plant, was affected after the first year because of emerging leaves encountering oil. Certain aquatic insects and invertebrates that lived in these plant beds were reduced in numbers, presumably from entrapment in the oil on plant stems. Some of the insects were still absent six years after the spill. There were no fish in this pond; therefore, the impact of the loss of a prey base to the fish could not be measured. Reducing food resources in a closed lake or pond, as described above, would decrease fitness and potentially reduce reproduction until prey species recovered.

Another potential impact could occur if oil that spilled before or during the spring floods (such as may occur from a structural failure) was dispersed into some of the tundra lakes that have continuous or ephemeral connection to the rivers and large creeks (Section 3.3.2.2 for discussion of perched, tapped, and drainage lakes). Lethal effects to fish in streams and some lakes are unlikely during high water events such as breakup because toxic concentrations of oil are unlikely to be reached. However, toxic levels may be reached in lakes that are normally not connected to the river/creek system except during the spring and maybe fall high-water periods. Fish are transported to these lakes and become “landlocked” until the next high-water event. If the oil concentrations in the water column reach toxic levels, these fish could suffer mortalities or injury.

Although lethal effects of oil on fish have been established in laboratory studies (Rice et al. 1979, Moles et al. 1979), large kills following oil spills are not well documented. This is likely because toxic concentrations are seldom reached. In instances where oil does reach the water, sub-lethal effects are more likely to occur, including changes in growth, feeding, fecundity, survival rates, and temporary displacement. Other possibilities include interference with movements to feeding, overwintering, or spawning areas, localized reduction in food resources, and consumption of contaminated prey.

Most oil spills are not expected to have a measurable effect on arctic fish populations in the Plan Area over the life of the CPAI Development Plan or the FFD. Oil spills occurring in a small body of water containing fish with restricted water exchange might be expected to kill a small number of individual fish, but are expected to have no measurable effect on arctic fish populations.

A potential spill from an HDD line under the Nigliq Channel in Alternative D may impact water quality and fish directly and other water-associated resources (e.g., birds, riparian habitats) as well as subsistence and recreational uses of the downcurrent areas. The spill may take some time to work its way from the pipeline to the sediment surface and, in a sudden or large to very large spill, the spill may be detected before it reaches the Nigliq Channel water body. However, if the spill goes undetected either remotely or during surveillance inspections, it will be underwater and may go on for days to weeks. Especially under ice, it will likely not be detected for months and the volume of oil could be substantial compared to the volume of the receiving water downcurrent from the spill. Fish in the deeper pools may be exposed and would likely die. Early-arriving birds may be exposed in any open water pools and cracks in the river ice. A catastrophic failure of the HDD pipeline would be more easily and rapidly detected. However, depending upon the season of occurrence (e.g., winter freeze-up compared to spring break-up or to summer open water), containment and cleanup of a large or very large oil spill could be difficult. The energized fluid released would mix with water and the oil is likely to emulsify, dissolve, disperse, and adhere to sediment particles. Fish as well as birds, other aquatic animals and plants, and riparian habitats could all be impacted for a substantial portion of the downcurrent channel.

The effects of salt water spills on freshwater fish populations would depend on the specific location, size, and timing of the spill. No effect would be expected during the winter period when the surface is already covered by ice. During the spring and summer, impacts from large quantities of salt water entering a fish-bearing freshwater environment would range from no effect on freshwater fish to lethal effects, depending on the specific water body involved, the size and salt concentration of the salt water spill into that water body, and the rate of freshwater exchange within that water body. Migratory fish are less likely to be affected by salt water spills because of higher tolerance to salt water and the probability that most would have already left the freshwater environment by spring in their migration to sea. In large freshwater bodies, salt water spills are expected to have from no effect to sub-lethal effects on freshwater fish because the salt water would be rapidly diluted to ambient salinity. In small water bodies with restricted water exchange, lethal effects could result from a medium to large salt water spill. Because of the small size of most of the salt water spills anticipated, and the low diversity and abundance of freshwater fish in most of the Plan Area, salt water spills are not expected to have a measurable effect on arctic fish populations in the Plan Area over the production life of the field.

This impact assessment also applies to the FFD for the Plan Area.

Marine Fish

In the CPAI Development Plan, even the large spills are unlikely to reach the marine waters of Harrison Bay at concentrations that would affect marine fish or their prey (Section 4.3.3). In all alternatives, a large spill from CD-3, or the pipelines between it and CD-1, could affect the estuarine fish in the Colville River Delta but probably would be diluted by the time the spill reached the much larger volume of marine water in Harrison Bay.

In the FFD, a large spill from HP-14, HP-13, or HP-12 could have the same limited impact to marine fish as a spill from CD-3, while a large spill from HP-22 could have a limited impact to the marine fish in the adjacent nearshore Beaufort Sea. The impacts are likely to be low-level chronic toxicity effects that would disappear in a few hours to days with additional dilution and weathering of the toxic materials.

Birds

Most spills are very small to medium volume and are contained on the ice or gravel pads, roads, and airstrips. If the spill does leave the gravel or ice structures, it is usually confined to small areas of the tundra vegetation and small ponds adjacent to the structure. Most pipeline spills are also contained on the tundra or tundra ponds, especially during the two thirds of the year when there is snow and ice over the tundra and water bodies. Some small to medium spills from pipelines or from vehicle accidents on bridges and culverts could result in spilled material entering flowing water bodies.

Spills on or near the roads, pads, or airstrips would have no impact to populations of birds, although a few individual shorebirds, waterfowl, raptors and very few passerine birds could be exposed to the spilled material, especially oil. These individuals are likely to die from hypothermia or from toxic effects of ingesting the spilled material. There could be some impact to a few individual birds, especially waterfowl and shorebirds using the small tundra ponds and creeks affected by the small to medium spills. Again, there would not be a population-level impact.

A large spill onto “dry” tundra could cause the mortality of small numbers of shorebirds and passerines from direct contact, especially with oil. If the spilled material were to enter local or inter-connected wetlands, small numbers of loons and waterfowl, plus additional shorebirds, could be exposed. Numbers of individuals oiled would depend primarily upon wind conditions, and numbers and location of birds following entry of the spill into the water. Impacts would not be detectable at the population level.

If the spill were to enter a creek or river, ranging from the many small creeks in the Plan Area to the Nigliq Channel and Colville River Delta, a variety of waterfowl and shorebird species could be present, particularly where the river empties into the estuarine environment. Such losses are likely to cause negligible impacts at the regional population level.

If gyrfalcons, peregrine falcons, rough-legged hawks, or owls were breeding in the spill vicinity, they could become secondarily oiled by preying on oiled birds. Mortality of breeding falcons likely would represent a minor loss for the local population, but (as with rough-legged hawks) is not likely to affect the regional population.

If a large spill were to move into the Colville River Delta, mouth of the Nigliq Channel, or the estuarine habitats of the other major rivers in the Plan Area, several waterfowl species that breed, stage, or stop there during migration would be at risk. A spill entering a river in spring could contaminate overflow areas or open water where spring migrants of several waterfowl species concentrate before occupying nesting areas.

It is unlikely that even a large spill would reach the marine environment with a substantial concentration of floating oil. If it did, it could contact loons and flocks of brant, long-tailed duck, and eiders staging before or stopping during migration in protected coastal habitats as well as black guillemots. Physiological effects on individual birds would be the same as described in the Northeast National Petroleum Reserve-Alaska IAP/EIS (BLM and MMS 1998). Lethal effects are expected to result from moderate to heavy oiling of any birds contacted. Light to moderate exposure could reduce future reproductive success because of pathological effects that interfere with the reproductive process caused by oil ingested by adults during preening or feeding.

Physiological effects of oil on individual birds would be the same as described in the Northeast National Petroleum Reserve-Alaska IAP/EIS (BLM and MMS 1998). Lethal effects are expected to result from moderate to heavy oiling of any birds contacted. Oiled individuals could lose the water repellency and insulative capacity of their feathers and subsequently die from hypothermia. Light to moderate exposure could reduce future reproductive success as a result of pathological effects on liver or endocrine systems (Holmes 1985) that interfere with the reproductive process and are caused by oil ingested by adults during preening or feeding. Stress from ingested oil can be an additive to ordinary environmental stresses such as low temperatures and metabolic costs of migration. Oiled females could transfer oil to their eggs, which at this stage could cause mortality, reduced hatching success, or possibly deformities in young. Flocks of staging eiders could contact oil in nearshore areas. Oil could adversely affect food resources, causing indirect, sub-lethal effects that decrease survival, future reproduction, and growth of the affected individuals. Because the spectacled eider population is small and declining, even relatively low mortality could represent a detectable impact.

Some brood-rearing, molting, or staging loons, brant, long-tailed ducks, or other waterfowl could contact oil in coastal and estuarine habitats. Mortality of molting long-tailed ducks from a spill entering protected areas could be substantial, but the population effect would be difficult to determine because numbers of that species are stable, declining, or increasing in various areas (Conant et al. 1997, Larned et al. 2001). Flocks of staging eiders could contact oil in nearshore or offshore areas. In addition, several thousand shorebirds could encounter oil in shoreline habitats (e.g., river deltas), and the rapid turnover of migrants during the migration period suggests many more could be exposed. A spill that enters open water off river deltas in spring could contact migrant loons and eiders.

A pipeline spill of salt water used in the waterflood enhancement stage of production would kill salt-intolerant tundra vegetation near the pipeline. The amount of tundra habitat affected is expected to be no more than a few acres. Such a small area of degraded habitat is not likely to result in loss of productivity by displaced breeders, and the loss will not be detectable at the population level.

In addition to the expected mortality due to direct oiling of adult and fledged birds, there could also be: mortality of eggs due to secondary exposure by oiled brooding adults; loss of ducklings, goslings and other non-fledged birds due to direct exposure; and lethal or sub-lethal effects due to direct ingestion of oil or ingestion of contaminated foods (e.g., insect larvae, mollusks, other invertebrates or fish).

The impacts of FFD would be similar except that several additional pads (HP-4, HP-5, HP-7, HP-12, HP-13, and HP-14) and pipelines in the Colville River Delta represent potential sources of spills that could affect the eiders and their habitat.

Marine Mammals

Any spills to the tundra that do not reach a flowing river or creek would not affect marine mammals.

Most spills are very small to medium in volume and are contained on the ice or gravel pads, roads, and airstrips. Most pipeline spills also are contained on the tundra, especially during the two-thirds of the year when there is snow and ice over the tundra and water bodies. There would be no impact of these spills to marine mammals.

Large spills that directly or indirectly enter flowing water of the rivers or creeks that discharge to Harrison Bay, the Colville River Delta (including the lower Nigliq Channel), and Kogru River mouth could have limited impacts on some of the marine mammals.

No impacts should occur to migrating bowhead whales whose migration route typically is well offshore of Harrison Bay and the immediately adjacent nearshore Beaufort Sea, where low concentrations of oil from a large spill might occur in open water season. Any spill reaching this marine environment would disperse to undetectable levels before it reaches migration routes and offshore habitats of the bowhead.

Some seals could be exposed to oil if a spill were to reach the marine environment of Harrison Bay or the areas they occupy in the Colville River Delta, lower Nigliq Channel, Kogru River, and the adjacent nearshore Beaufort Sea during the open water season. Such an event could result in the oiling of those seals directly exposed. It is possible, though unlikely, that a small number of these exposed seals could die, but the population would be likely to replace this loss within one year.

A large spill would not be likely to affect many bearded seals, walruses, beluga or gray whales because these species tend to occur offshore of Harrison Bay. Such a spill would be expected to disperse before it reached the migration routes and offshore habitats of these species. Such a spill would not be likely to have any food chain effects on marine mammals.

Polar bears would be most vulnerable to an oil spill were the spill to reach the coastal habitats of Harrison Bay. The number of bears likely to be contaminated or to be indirectly affected by a local contamination of seals probably would be small. Even in a severe situation where a concentration of perhaps 10 bears (such as at a whale-carcass site) were to be contaminated by the spill and all 10 bears were to die (a highly unlikely worst-case situation), this one-time loss would not be expected to affect the regional polar bear population.

In the CPAI Development Plan, a large spill from CD-3 or the pipeline between CD-3 and CD-1 where it crosses river channels or from the Nigliq Channel crossing are the most likely to have any impact on marine mammals, primarily polar bears foraging in the coastal areas and on seals in the Nigliq Channel. All other potential sources are far enough from the marine environment that spills are not likely to reach the marine mammals. There is a slightly reduced risk of large spills occurring in the ice-free season in Alternative D, compared to Alternatives A through C and F, because of the lack of vehicles and heavy equipment that might spill a container or tank of material or that could cause a rupture of a pipeline over a bridge, such as the Nigliq Channel or Ublutuoch River.

In the FFD, the same impact assessment is generally applicable. However, large spills from additional pads (HP-22, HP-5, HP-7, HP-12 to HP-14) plus the pipelines connecting them to flowing waters also could have similar impacts to marine mammals as described for CD-3.

Terrestrial Mammals

Most spills would be very small to medium volume and would remain on the ice or gravel pads, roads, and airstrips where they would be expeditiously cleaned. Some of the spilled material, especially from the medium spills, might reach the tundra adjacent to the gravel or ice structures. In addition, small spills from pipelines could reach the tundra anywhere along the pipeline and affect the tundra. These spills, especially oil, would have a very limited impact on the terrestrial mammals found in the Plan Area. The extent of impacts would depend upon the type and amount of materials spilled; the location of the spill; the type of habitat impacted; the mammals' distribution, abundance, and behavior at the time of the spill; and the effectiveness of the response. The proportion of habitat impacted would be very small relative to the size of the habitat utilized by most of the mammals. In addition, most of the mammals would not be present or would be limited in abundance and distribution in the Plan Area during the winter months; they would not be exposed to winter spills. The potential impacts to terrestrial mammals of these small to medium spills would be lower for Alternative D than for Alternatives A through C and F because the risk of spills to the habitat during the early summer through fall period is lower with the reduction of vehicle and equipment traffic.

A large spill that reaches the tundra adjacent to the gravel or ice pads, roads, or airstrips, or pipeline corridors could affect the terrestrial mammals directly or indirectly through impacts to their habitat and/or prey.

Caribou and other terrestrial mammals such as moose and muskoxen could become oiled by direct contact with oiled vegetation or soil, or by ingesting contaminated vegetation. Adult caribou, moose, and muskoxen that become oiled are not likely to suffer from a loss of thermal insulation during the summer, although toxic hydrocarbons could be absorbed through the skin or inhaled. However, the oiling of young calves could reduce thermal insulation, leading to their death (BLM and MMS 1998). Oiled caribou, moose, and muskoxen hair would be shed during the summer before the winter fur is grown. If caribou were oiled in the winter after shedding their summer coats, oiling would not be expected to substantially affect thermal insulation, because the outer guard hairs of caribou are hollow and thus retain their insulating properties even when coated with oil. No documented caribou deaths have been attributed to the spills associated with TAPS. Toxicity studies of crude-oil ingestion in cattle (Rowe et. al. 1973) indicate that anorexia (measurable weight loss) and aspiration pneumonia leading to death are possible adverse effects. Caribou, moose, and muskoxen that become oiled by contact with a spill in contaminated lakes, ponds, rivers, or coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin.

A large spill would likely affect tundra vegetation, the principal food of the larger mammals. Caribou, moose, and muskoxen probably would not ingest oiled vegetation, because they tend to be selective grazers and are particular about the plants they consume (Kuropat and Bryant 1980). For most spills, control and cleanup operations (ground traffic, air traffic, and personnel) at the spill site would frighten caribou, moose, and muskoxen away from the spill and reduce the possibility of these animals grazing on the oiled vegetation. In most cases, onshore oil spills are not expected to affect caribou, moose, and muskoxen through ingestion of oiled vegetation. However, the spilled material could affect the vegetation and reduce its availability as food for several years (Section 4.3.3), though this impact would be limited in area and would not affect the overall abundance of food for the grazing mammals.

For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and there would be a greater likelihood of animals exposed to the weathered oil. Cleanup success could vary depending upon the environment. Over time, any remaining oil would gradually degrade. Although oiling of animals would likely not remain a threat after cleanup efforts, some toxic products could remain for some time. Depending upon the spill environment, part of the oil could persist up to five years (BLM and MMS 1998).

Grizzly bears depend on coastal streams, beaches, mudflats, and river mouths during the summer and fall for catching fish and finding carrion. If an oil spill were to contaminate beaches and tidal flats along the Harrison Bay coast or the Colville River Delta, or the shore of other water bodies in the Plan Area, some grizzly bears would likely ingest contaminated food, such as oiled birds, seals, or other carrion (BLM and MMS 1998). Such ingestion could result in the loss of a few bears. Brown bears on the Shelikof Strait coast of Katmai National Park (an area contacted by the *Exxon Valdez* oil spill) were observed with oil on their fur and were consuming oiled carcasses (Lewis and Sellers 1991). A study of the exposure of Katmai National Park brown bears to the *Exxon Valdez* oil spill through analysis of fecal samples indicated that some bears had consumed oil or were exposed to oil; one young bear that died had high concentrations of aromatic hydrocarbons in its bile and might have died from oil ingestion (Lewis and Sellers 1991). Anecdotal accounts of polar bears deliberately ingesting hydraulic and motor oil, and foreign objects from human garbage sites, suggest that both bear species are vulnerable to ingesting oil directly, especially from oiled carrion and other contaminated food sources (Derocher and Stirling 1991). Skin damage and temporary loss of hair can result from oiling of bears, with adverse effects on thermal insulation (Derocher and Stirling 1991).

Small mammals and furbearers could be affected by spills due to oiling or ingestion of contaminated forage or prey items. These impacts would be localized around the spill area and would not have population level impacts.

A salt water spill could kill plants on contact and increase soil salinity to the point that many species could not survive (McKendrick 2000b). Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have adverse effects on salt-intolerant vegetation near the salt water spill, but the amount of tundra habitat affected would be small, usually no more than a few acres. Thus, potential salt water spills are not likely to affect forage availability for caribou, muskoxen, moose, or other terrestrial mammals in the Plan Area.

The impact assessment is also applicable to the FFD. In the FFD, several of the pads, roads, and pipelines, and thus potential for large spills, are closer to foraging habitats of grizzly bears and caribou than are the five satellite facilities of the CPAI Development Plan.

Economy

The vast majority of spills would be very small to medium size in volume, contained on the ice or gravel structures, or be limited to the tundra adjacent to the ice and gravel structures. They would not affect the local economy including the Helmericks commercial fishery on the Colville River Delta.

A large spill of oil, salt water, or chemicals that enters the Colville River from CD-3 or, in the FFD, from HP-4, HP-7, HP-12, HP-13, HP-14 or pipelines joining these pads, could potentially affect the commercial fish populations (e.g., arctic cisco, least cisco, and humpback whitefish) and/or the Helmericks fishing gear (Section 3.3.2). The nets, boats, personal gear, and other gear used in the fishery could become oiled if the oil reaches the fishing area. This could close the fishery, resulting in the loss of jobs and income for the family. In addition, depending upon the publicity the spill receives, the customer demand for potentially “tainted” fish could drop, resulting in a reduction or loss of demand for the fish and thus a reduction of loss of income and jobs.

Limited employment would be generated from cleanup of very small to medium spills (up to 1,000 gallons) on pads, roads, airstrips, or pipeline corridors. Even large spills of up to 100,000 gallons might not generate many additional jobs depending upon where the spill occurs. Onsite workers doing other operations and other response personnel from the North Slope, as well as other locations in Alaska, would clean up most small to medium spills. A large spill that enters the flowing water, especially where the oil strands along a substantial stretch of shoreline or river bank, would likely require the temporary employment of local village response teams and additional labor to clean up the oil.

Socio-Cultural Characteristics

Effects on the socio-cultural systems of local communities could come from interference with subsistence-harvest patterns from large oil spills and oil-spill cleanup as well as stress due to fears of a potential spill and the disruptions it would cause. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed for at least an entire season if there are concerns over the tainting of fish and other subsistence resources or potential displacement of subsistence resources and hunters. If a large spill contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and would alter or reduce access to these species by subsistence hunters. The overall effects from these sources are not expected to substantially change ongoing socio-cultural systems.

Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and disrupt some socio-cultural systems but most likely would not displace these systems. The employment increase could have sudden and abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup is unlikely to add population to the communities because administrators and workers would live in separate enclaves. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs. Oil spills producing disruption of this magnitude are not expected from Northeast ASDP activities.

This impact assessment also applies to the FFD for the Plan Area.

Cultural Resources

Most spills are confined to a pad or roadway or to an area adjacent to them. The primary exceptions are spills from pipelines to tundra remote from the roads and pads. In the construction stage, most spills would occur on an ice pad or ice road during winter conditions, where snow and ice would limit impacts to cultural resources and cleanup would be less invasive than in a summertime terrestrial spill. Further, the type and location of cultural resources usually are clearly identified before construction begins so that they would not be affected by most spills or by subsequent spill cleanup. The effects of spills and spill cleanup associated with drilling and production would be similar to those associated with construction activities except that they could occur during the snow-free months. Although cleanup from these spills could be more invasive because of the non-frozen surface environment, there is little chance that cultural resources would be affected by either the spill or cleanup. Because the occurrence of most of the surface and subsurface cultural resources near the facilities are documented, the risk of impact is low.

This impact assessment also applies to the FFD for the Plan Area.

Subsistence Harvest and Uses

Impacts on subsistence-harvest patterns would result from impacts to subsistence resources. The direct and indirect effects of spills on individuals as well as populations of terrestrial mammals, birds, freshwater fish, marine fish, bowhead whales, beluga whales, and other marine mammals (ringed, spotted, and bearded seals; walruses; polar bears; and gray whales) are analyzed earlier in this section.

The vast majority of spills are very small to medium in size, are confined to the ice or gravel structures or immediately adjacent habitat or to the pipeline corridor, and are confined to relatively small areas even when they do affect the tundra or most tundra ponds, lakes, or small creeks. The potentially impacted areas would constitute a small proportion of the North Slope habitat utilized by the subsistence species. The spills and their associated cleanup activities under either the CPAI Development Plan or the FFD are not likely to affect subsistence resources or subsistence harvests.

Large spills, particularly those in remote sections of the pipelines or in the larger rivers and creeks, could affect a limited proportion of the habitat for subsistence species such as caribou or waterfowl, or a small proportion of the subsistence resource population itself. The direct and indirect ecological and physiological impacts to the resources are likely to be limited to the immediate area of the spill and could have a duration up to a year or two after the spill.

A large spill could result in a major response and cleanup effort, especially for a spill that is in habitat remote from the ice or gravel structures. The response could include the presence of hundreds of humans, boats, and aircraft that would displace subsistence species and alter or reduce access to these species by subsistence hunters. This impact would last as long as the major response activity continues, probably no longer than two seasons and generally less than one.

For large spills, especially of oil or hazardous substances, most of the subsistence resources would move to adjacent unaffected areas. As discussed more fully in Sections 4A through 4D and 4F.4.3, some of the subsistence users may follow the resources and other users may not utilize the resources because of concerns about contamination of the resources. From a technical “protection of human health” perspective, the resources may meet all government agency regulations regarding safety for ingestion or dermal contact in a relatively short time after the spill has been cleaned up. Often, one of the end points for determining that the cleanup can be terminated is that the food resources, water quality, and essential habitat variables meet government agency requirements for the protection of human health. These standards are typically based on physiological and toxicological (e.g., cancer health risk) criteria and not on cultural perceptions.

However, scientifically measurable quantities of contaminants in subsistence species, Traditional Knowledge criteria, and the perception of contamination by subsistence users are independent components contributing to the decision by subsistence users to harvest a resource. Subsequent to harvest, Traditional Knowledge-based criteria are used to determine the fitness of the harvested resource for consumption and the appropriate or safest method for preparation, consumption, distribution, and storage. In the case of contamination that shows no outward symptom or sign (e.g., PCBs, radioisotopes, and heavy metals, most of which are not an issue for the CPAI Development Plan or FFD), the perception of contamination is the basis for a behavioral response by subsistence users (Usher et al. 1995). This does not reflect a lack of sophistication on the part of subsistence hunters but rather a lack of the scientific tools and strategies (e.g., field test kits) for addressing a novel risk. Where the contamination event is undeniably evident, as in the *Exxon Valdez* oil spill, behavioral responses by subsistence users may be dictated by a number of other factors, such as resource availability, resource health, financial resources, and regulatory constraints (Fall and Utermohle 1999, Fall et al. 2001).

An illustrative example is the harvest of caribou, wherein a slow or weak animal, as demonstrated by a failure to try to flee hunters, is considered to be unhealthy independent of scientifically testable notions of contamination. Contamination by chemicals is only one possibility for this behavior, which may also stem from natural causes such as parasite overload, brucellosis, starvation, or injury (Usher et al. 1995). With no local expertise in environmental toxicology and no means to definitively test subsistence resources, the cumulative experience of generations of subsistence resource users is the final arbiter of the fitness for consumption of a resource. Traditional Knowledge of caribou health would direct the hunter to look for morphological anomalies in the meat and organs of the harvested animal to determine the fitness of the harvested animal for human or domestic animal consumption (Usher et al. 1995, Fall et al. 2001). Inupiat hunters interviewed in 2003 approached these anomalies based on their judgment and experience, with some choosing to discard some or all of a caribou found to be sick after harvest while others selectively removed parts deemed unfit for consumption (SRB&A 2003a).

For all resources, the perception of contamination in the absence of testing (e.g., abscesses, pus spots, discoloration, anatomical deformity, and taste) or the tested presence of contaminants at levels deemed acceptable by the government may discourage resource users from harvesting and consuming the resource for multiple harvest seasons. If harvesters perceive the resource habitat or traditional harvest location to be contaminated, they may go farther from the community or traditional harvest location to harvest uncontaminated resources (Fall and Utermohle 1999). Possible results of this change may be shifts in species emphasis, the need to purchase some formerly subsistence foods to reinforce perceptions of safety, and the need to expend more time, effort, and money pursuing resources at more distant locations with greater commensurate accident risks for some modes of travel (Fall and Utermohle 1999, Fall et al. 2001).

Land Uses and Coastal Management

The vast majority of all spills are confined to a pad, road, or airstrip, to an adjacent area, or to the area under a pipeline. Spills that impact the tundra or water, whether the source is a pipeline, bridge, culvert, or pipeline over water, could affect land uses or Coastal Management policies and regulations.

Most small spills are quickly contained or cleaned up. The impacts of such spills are expected to be minor, especially given the required measures addressing prevention and response described in Section 2. No conflicts with any of the land uses or statewide standards or district enforceable Coastal Management policies are anticipated.

A large spill, especially if it reaches a water body such as the Nigliq Channel or Ublutuoch River, could influence local subsistence resources, habitats, and land and water quality in the Plan Area. If a spill occurs during the winter months, cleanup efforts would be conducted during the winter months and would be less likely to affect the resources or uses of the coastal zone. However, even if a large spill were to occur during the summer months, it is not anticipated that any species would become unavailable or unharvestable because of such a spill. While localized availability and harvestablility could be affected, it is expected that subsistence activities could continue outside the localized spill area. Water quality in the area of the spill could be compromised but the effect would be short term. Habitats also would be influenced locally if a spill were to occur during summer months or break-up. Oil that is stranded on shorelines may persist for several years to decades, depending upon the type of oil and exposure to physical and biological weathering processes.

This impact assessment also applies to the FFD for the Plan Area.

Recreation Resources

Most spills are very small to small and few are medium to large. Nearly all of these spills would be confined to pads, roads, airstrips, or the immediate vicinity, and to the pipelines. Therefore, impacts on wilderness-type values of scenic quality, solitude, naturalness, or primitive/unconfined recreation resulting from spills likely would be confined to the same area.

A large spill, most likely from a pipeline or from a tank truck accident that reaches a creek or river (e.g., Ublutuoch River) including the Nigliq Channel in the break-up to initial freeze-up season could move rapidly downstream. The spilled material, especially oil, might be visible and thus could have a short-term (and possibly long-term) impact on recreation values. Fishing, boating, camping, scenic values, and other recreation pursuits could be affected as a result of an oil spill in a riverine environment that is used by recreationists. The obvious short-term effects would be the oil residues in areas of use. The long-term effects would possibly be the reduction or loss of fishing and diminished scenic value of the area, as oil residue could take a long time to weather and would not be detectable.

A spill of salt water and other miscible materials could have less short-term impact on recreational uses because it could be less visible. However, it could affect the fish, birds, and, over a longer period, the vegetation, which could diminish the recreational value and use of these resources.

This impact assessment also applies to the FFD for the Plan Area.

4.3.4 VERY LARGE VOLUME SPILLS

4.3.4.1 Introduction

This section evaluates the rate of a VLVS; greater than 100,000 gallons) (Section 4.3.2 for spill sizes) and the potential impacts to the environment for both the CPAI Development Plan and the FFD.

A review of the ADEC North Slope spill database for 1995 to 2003 (ADEC 2003d) shows one VLVS in March 1997 of 994,400 gallons of salt water at DS 4 in the Prudhoe Bay Unit when salt water broached to the surface and was completely contained on the pad (B. Smith, pers. comm. plus excerpts of the Incident Report of the Investigation Team). One other spill occurred that approaches the VLVS criterion of greater than 100,000 gallons: a 92,400-gallon produced water spill resulting from corrosion at APF-1 in April 2001. Mach et al. (2000) report only one Alaska North Slope oil spill of 100,000 gallons and that was jet/turbine fuel spilled in 1982 by Wien Airlines at the Deadhorse Airport. It was not a spill from the oil field operations. No very large volume oil spills have been reported since January 1995; the largest was a 38,000-gallon crude oil spill. None of these spills occurred at the Alpine Unit.

A further review of the 1971 to 1994 ADEC database[19] for spills on the North Slope shows approximately 6,900 spills, most of which occurred in the oilfields[20,] and shows 4 spills estimated to be greater than 100,000 gallons. All occurred at gravel pads between 1983 and 1991. They include 1,050,000-, 420,000-, and 147,000-gallon spills of drilling mud, and 357,000 gallons of produced water. No other VLVSs were reported of salt water, produced fluids, or oil in the North Slope oilfield before 1995.

4.3.4.2 VLVS Scenarios

The VLVS scenario has been analyzed for crude-oil spills in several North Slope environmental evaluations, which are incorporated by reference (BLM and MMS 2003, BLM and MMS 2002, TAPS Owners 2001a, PAI 2002a, CPAI 2003f). The definition of a VLVS varies among these documents, depending on the situation being analyzed and the potential source of the spill. The volume ranges from approximately 117,600 to 126,000 gallons (MMS 2002, PAI 2002a) to 5,040,000 gallons (BLM 2003b), based on various risk assessments.

For purposes of a cleanup response scenario, the CPAI Alpine ODPCP (CPAI 2003f) for the existing Alpine field wells uses a VLVS of 3,591,000 gallons for a well blowout. This value is based on known production rates

---

[19] According to Luick (pers. comm. 2003), the pre-1995 database was compiled in R-Base and the input data did not always provide information in a complete and/or consistent manner for every incident. However, the database provided to ENTRIX by the ADEC is sufficient to provide a general picture of the pre-1995 North Slope spill history for this scenario development and impact analysis.

[20] Spills at Barrow and other North Slope areas (but not oilfield locations) are included. However, they do not constitute many spills (the exact number was not determined) and do not materially change the following discussion. The one exception is for VLVS. Besides the four described in this paragraph, there were five other VLVSs at North Slope villages or other locations.

of the wells along with the appropriate ADEC-approved credits taken, and accounts for evaporation and volatilization of the light ends (e.g., benzene, toluene), but without considering that as much as 80 percent of the material from a blowout could be non-oil (i.e., brine, natural gas, grit). A second possible VLVS assumes approximately 43,134 gallons of sales oil could reach the Colville River by flowing over the tundra. As indicated in Table 2.3.11-2, pads are generally greater than or equal to 0.5 miles from rivers and creeks, so most of the fluids from a blowout would be deposited on tundra and associated ponds or lakes.

For the proposed CPAI Development Plan and the FFD, the potential well production characteristics and rates are not known (Shifflett, pers. comm. 2003) so the ADEC blowout default values of 231,000 gallons per day for 15 days could be used to provide a total of 3,465,000 gallons of produced fluids that potentially could be spilled. Some of this would evaporate and some (perhaps the majority) would consist of natural gas, which would volatilize.

Another possible VLVS scenario is the rupture of the proposed pipelines for produced fluids or salt water, and for the FFD, the Sales Oil Pipeline crossing the Nigliq Channel or other major rivers and creeks (Table 4.3.3-1). If only one of the co-located pipelines were severed completely between valves or vertical loops, up to approximately 195,000, 450,000, and 5,600 gallons of produced fluids, salt water, or diesel, respectively, could be discharged from the pipeline. For the FFD, up to 330,000 gallons of Sales Oil Pipeline could potentially be spilled to the tundra and 23,100 gallons of Sales Oil to the Nigliq Channel if a new pipeline were required to transport oil from HPF-1 and/or HPF-2 to APF-1, and if the pipeline were located on the bridge. If all the co-located pipelines were completely ruptured (e.g., because of a truck or heavy equipment crash, or loss of a bridge in a major flood) in the CPAI Development Plan, total spill volumes potentially could amount to approximately 32,000 gallons at the Nigliq Channel and Ublutuoch River crossings, and approximately 220,000 gallons in the Colville River Delta between CD-1 and CD-3. A complete rupture of the lines between CD-6 and CD-7 could potentially result in a spill of approximately 523,000 gallons on the tundra and/or tundra ponds and lakes between the pads. This tundra spill is intended to represent spills between any of the production pads in the CPAI Development Plan and between production pads and the hypothetical processing facilities (HPF-1 and HPF-2) in the FFD, though the volume spilled would likely be smaller in most instances.

This EIS considers spills from greater than 100,000 gallons to the hypothetical maximums postulated for the CPAI ODPCP (for example, 4,725,000 gallons) to be VLVSs in terms of the potential impacts. In addition, for purposes of this analysis, a VLVS is a spill that would affect a substantial area of tundra and possibly surface water beyond gravel pads, roads, or airstrips and that could require substantial resources from the North Slope for response, control, and cleanup.

4.3.4.3 Rate of Very Large Volume Spills

Five VLVSs have been reported for the North Slope oilfield since 1977 in the ADEC databases, and the total oil production has been approximately 1.6 trillion gallons in that time (www.tax.state.ak.us/programs/oil/production/index.asp). This amounts to approximately one VLVS for every 300 billion gallons of oil, and none of these VLVSs consisted of oil or produced fluids. Another indicator is that approximately 2,968,000 gallons of material (none that are oil or produced water) were spilled only in VLVS or approximately one gallon spilled for every 540,000 gallons of oil produced from the North Slope. Thus, the rate of occurrence of VLVSs of oil (or oil in produced fluids) in the Plan Area approaches zero. This rate is still extremely low for all hazardous materials combined.

Based on the recent history of reported North Slope spills and proposed oil production in the CPAI Development Plan, the most likely potential VLVSs would be composed of produced fluids or salt water. The occurrence of VLVS of drilling muds from reserve pits is much less likely now than it was pre-1995 because of the changes in drilling operations and procedures for handling drilling muds. In particular, reserve pits are no longer used on the North Slope. The largest hypothetical spills would be produced fluids from a well blowout which have not yet occurred on the North Slope. The actual largest spills in the ADEC 1995-2003 database are of salt water and produced water.

Therefore, the following VLVS impact assessment is based primarily on potential spills of produced fluids and/or salt water.

4.3.4.4 Behavior and Fate of a Very Large Volume Spill

A VLVS would most likely result from a major pipeline break, well blowout, or uncontrolled release. In the latter two cases, some or much of the spilled material could be contained on the pad or on the tundra in the immediate vicinity. However, in all three cases, there is a high likelihood that the oil and/or salt water would affect the tundra, possibly relatively remote from the road or pads in pipeline spills. Depending upon proximity and season, the oil and/or salt water could also reach wet tundra, tundra ponds and lakes, creeks, larger rivers, estuaries, Harrison Bay, and the nearshore Beaufort Sea.

The processes that affect the fate and behavior of the spilled material are described in Sections 4.3.2.3 and 4.3.2.4, as well as in several previous North Slope EISs, which are incorporated by reference. The primary difference between the discussion about behavior and fate of very small to large spills and VLVSs, is the larger scale of the VLVSs, i.e., generally a larger area would be affected, the duration of the impact would be greater, the magnitude of the impacts would be greater, the time required for weathering would be longer, and the response/cleanup effort could be much greater.

In summary, the behavior and fate of a VLVS from the CPAI Development Plan or the FFD would be influenced by the following factors:

- Type and volume of material spilled
- Duration of the release (e.g., essentially instantaneous in a pipeline rupture compared to an extended period for a well blowout)
- Topography of the tundra or water bodies
- Season (including temperature, wind, and precipitation)
- Water velocity and flood stage if spill reaches flowing waters
- Response actions
- Vegetation, snow and ice cover

WINTER SEASON

During the two-thirds of the year when the tundra typically is covered with snow, the water bodies are covered with ice, air temperatures are well below freezing, and there is little, if any, water flow in rivers, a VLVS generally would be limited in aerial dispersal far from the source. Oil would cool rapidly to a point where the viscosity is high, and dispersal would be limited. However, a large volume release of warm oil released as a fluid, rather than a mist or spray to the tundra, may melt through snow to the tundra vegetation and underlying soil before the oil cools enough to stop flowing. The snow would act as a sorbent and retain much of the oil once the oil cooled. VOCs will evaporate more slowly than in warmer periods so the potential toxicity of the oil to vegetation, fish, and wildlife would last longer. However, there are generally fewer biological resources other than tundra vegetation to be exposed to the oil in winter. Salt water will begin to freeze[21] when temperatures are well below freezing. Both the oil and salt water could be removed from the tundra or water surfaces before they become incorporated into the soil, vegetation, or water over large areas. Also, the response actions to contain and clean up the spilled material would be less environmentally damaging if they are implemented to minimize surface disturbance or removal of vegetation and soil.

SPRING BREAK-UP

During spring break-up, snow melts off the tundra and the snowmelt, as well as rain ponds in depressions in the tundra or runs off to the creeks and rivers. The river water levels rise to flood stage and “break up” the ice in the

---

[21] Seawater with a salinity of 3.3 percent salt begins to freeze at approximately 28°F. As indicated by the presence of landfast sea ice in Harrison Bay and the nearshore Beaufort Sea, seawater can freeze rapidly to substantial thickness in a few days to weeks.

rivers. The ice and floodwaters are transported downriver, eventually to Harrison Bay where the freshwater floods over the landfast sea ice. The floodwaters also could overtop the riverbanks and temporarily flood the tundra, tundra ponds, and lakes.

During break-up, a VLVS of oil to the dry tundra could be limited in its dispersal because of the sorbent effect of the vegetation and/or snow. However, the oil could still cover several acres to tens of acres of tundra, and possibly more if it is aerially dispersed in a blowout. Oil spilled on wet tundra could be dispersed over a larger area as the wind blows it across the water surface and/or the sheet flow takes it toward the creeks, rivers, or tundra ponds and lakes. Oil spilled to tundra lakes and ponds would disperse over the water surface but eventually would collect on the downwind shores where vegetation would trap it. Oil spilled to flowing waters, especially the larger creeks and rivers (e.g., Nigliq Channel, Colville River Delta, Ublutuoch River, Fish and Judy Creeks, Kogru and Kalikpik rivers), would rapidly disperse in the flood waters and broken ice and be transported downstream toward Harrison Bay and the nearshore Beaufort Sea. The fate of this oil would depend largely upon the location of the spill and the volume and velocity of flood flows.

A VLVS of salt water would undergo much the same behavior and fate. However, the key difference for spills that reach flowing waters and large volume tundra lakes is that salt water would be rapidly diluted to ambient salinity of fresh water and therefore lessen its impact to the natural aquatic habitats. A VLVS to the tundra could kill or injure vegetation over the area exposed to the salt water.

Cleanup of oil spills during break-up is more challenging than in the winter. The CPAI ODPCP provides details of the necessary response actions, training programs, required equipment, etc.

SUMMER

In summer, a VLVS to the tundra would be limited in dispersal where the soil is relatively dry and the vegetation is at peak growth, thereby increasing the sorbent effect it has on oil. In addition, the VOCs would evaporate more quickly than in winter because of the higher air temperatures. Salt water could infiltrate farther into the soil than oil could to fill the interstices that were filled with ice in the winter. The warmer air temperatures would result in lower viscosity of oil, and salt water would remain liquid. In both cases, this would increase the dispersal over tundra, especially wet tundra, despite the sorbent effect of the vegetation. Spills to flowing water would be transported downstream but the velocity of transport and distance could be less than during break-up. More of the oil would be trapped in the vegetation and sediments of the riverbanks. The rate of dilution of salt water would not be as great as during break-up, and the salt water could cause higher salinities for longer in the freshwater systems.

FALL FREEZE-UP

During the freeze-up period, a VLVS of oil to the tundra would be similar to one in winter except there could be less snow and ice cover, and the snow could come and go for a few weeks. The air temperatures would not be as consistently cold so the viscosity of the oil and the evaporation of VOCs would vary with air temperature. Oil spilled to tundra ponds and lakes could become incorporated into the vegetation and soil, as well as the ice cover. As the ice freezes, the oil could become trapped unless it is removed during cleanup, an action that would be influenced by the thickness and strength of the ice. Oil spilled to flowing water could also become incorporated into or under the ice, not to be released until the following break-up and summer periods.

Salt water spills could become slush or solid ice, depending upon the temperature. This could enhance the removal where it is the appropriate response strategy.

4.3.4.5 Effects of Very Large Volume Spills

OVERVIEW

A VLVS is most likely to result from a major pipeline break, a well blowout, or uncontrolled release from a drilling or production pad. In the latter two cases, some (and possibly much) of the spilled material could be contained on the pad or on the adjacent tundra. However, in all three cases, there is a high likelihood that the oil and/or salt water would affect several to hundreds of acres of tundra and, in the case of pipeline spills, possibly relatively remote from the road or pads. The oil and/or salt water could also reach wet tundra, tundra ponds and lakes, creeks, larger rivers, estuaries including the Colville River Delta, Harrison Bay, and the nearshore Beaufort Sea, with the amount depending largely upon proximity of the spill source to the water bodies, season, and volume of the spill. In summary, a VLVS is more likely to affect a greater area and diversity of natural habitats and resources than are very small to large spills described in Section 4.3.3.

The range of potential impacts of very small to large spills is summarized in Section 4.3.3, as well as in several previous North Slope EISs, which are incorporated by reference. The primary difference between the previous discussion about potential impacts of very small to large spills and VLVSs is the larger scale of the VLVSs, i.e., generally a larger area is affected, duration of the impact is greater, magnitude of the impacts is greater, the time required for weathering is longer, and the response and cleanup effort could be much greater.

Therefore, the impact assessments from Section 4.3.3.3 are incorporated by reference into the following impact assessment of VLVSs in the CPAI Development Plan and FFD. The resource and issue categories in Section 4.3.3.3 are consolidated into physical, biological, and social/cultural/economic environments. These sections summarize the major differences in the impacts, mostly in magnitude and in areal extent, particularly into Harrison Bay and the nearshore Beaufort Sea.

PHYSICAL ENVIRONMENT

A VLVS could result in a thicker, continuous layer of oil over a larger area than smaller spills and may result in increased thermokarsting and potential incorporation of oil into the soil voids.

The impact to paleontological resources would be similar to that for small to large spills. Paleontological resources are typically subsurface, and the oil or salt water would not penetrate far into the soil.

Freshwater water quality and water resources are likely to experience greater impacts because the amount of oil or salt water relative to the volume of potentially influenced freshwater bodies would be greater, especially in tundra ponds, lakes, and wetlands where there is low to no flow. Therefore, the potential concentration of toxic materials or salts could exceed toxicity thresholds for aquatic plants, fish, and macroinvertebrates. In flowing waters, the relatively greater proportion of oil or salt water could result in more oil reaching the sediments and shoreline vegetation further downstream than for small to large spills.

The greatest difference in impacts to the physical environment is likely to be in the estuarine and marine water quality and to be largely limited to oil spills. Because the volume of oil in a VLVS is large, more of the oil is likely to reach the estuarine and marine environments of Harrison Bay and nearshore Beaufort Sea than in smaller spills, even if the spill were to occur well upstream on a major river or creek (e.g., at the Ublutuoch River crossing near CD-6 or in the FFD at HP-17 near Judy Creek or HP-8 near Nuiqsut). For VLVSs that occur near the Colville River Delta, Harrison Bay, or Beaufort Sea (e.g., for CD-3, Nigliq Channel crossing; for FFD, HP-7, HP-12, HP-13, HP-14, and HP-22), the oil is likely to quickly reach the estuarine and marine environments in relatively large amounts and relatively unweathered. In Alternative C where the Nigliq Channel crossing is further upstream toward Nuiqsut, a VLVS of oil may still reach the Harrison Bay area, though the total volume would likely be reduced compared to a spill from a crossing farther north.

BIOLOGICAL ENVIRONMENT

A VLVS of oil and/or salt water could affect several to tens or potentially hundreds (in a blowout) of acres of vegetation. The major difference from small to large spills is the greater areal extent of oiling or salt water inundation. A VLVS from FFD pads HP-13, HP-5, HP-7, HP-12, HP-13, and HP-14, as well as from the pipeline joining them, could affect more halophytic vegetation than would the CPAI Development Plan, which has only CD-3 on the Colville River Delta.

Freshwater fish populations are likely to be affected in the tundra ponds and lakes, as well as creeks and river channels, exposed to the oil and/or salt water. As discussed for freshwater quality (Section 4.3.3.3), toxic concentrations could exceed toxicity thresholds especially in smaller water bodies. Also, if the oil is discharged under ice or is entrained under the ice through cracks in it, especially in the Colville River or Nigliq Channel, it could collect in the deep pools where it has the potential to (1) depress dissolved oxygen levels as a result of the biodegradation of the oil, even at low microbial density and activity levels, and (2) exceed acute and chronic toxicity levels. Similarly, a VLVS of salt water, which is substantially denser than fresh water and would sink, could collect in these pools in winter if the salt water found cracks in the ice. The high salinity could cause osmotic stress in the fish and cause mortalities. There is no escape in winter for the fish from these reservoirs.

Unlike the impact assessment for small to large spills, a VLVS of oil could reach the marine environments of Harrison Bay and, especially in the FFD, nearshore Beaufort Sea (e.g., near HP-22) in concentrations and volumes great enough to contact the nearshore marine fish and benthic community. The impact is likely to be localized because the spilled oil would be diluted rapidly in the large volume of marine water and the toxic components would evaporate rapidly. Also, marine fish do not usually suffer many mortalities as a result of oil spills unless they are trapped in bays or similar areas. The benthic organisms could be exposed and some could die from the toxic effects of oil in the water or in the sediments. Again, the spatial extent is likely to be localized around the river discharge area.

A VLVS of oil is likely to affect substantially more shorebirds, passerines, gyrfalcons, hawks, and other terrestrial birds than would a small to large spill. The areal extent and thus potential for direct or indirect exposure increases with the VLVS. The number of individuals exposed and affected would not likely have an impact on the regional population size. Waterfowl, loons, geese, gulls, endangered spectacled eiders, and other birds that spend much to most of their time on the water resting, feeding, or molting, or nesting immediately adjacent to the water, could be impacted in large numbers, depending upon the distribution of oil, behavior of the birds, and their density. If large volumes of surface oil reach the estuarine portions of the rivers, the Colville River Delta, mouth of Nigliq Channel, or Harrison Bay during the summer season, large numbers of birds would likely be oiled and ultimately die. The probability is greater in the FFD because more pads and pipelines in the Colville River Delta and coastal habitats are key nesting, resting, feeding, and molting/staging areas for these migratory birds. In addition to the expected mortality due to direct oiling of adult and fledged birds, impacts could also include mortality of eggs due to secondary exposure by oiled brooding adults; loss of ducklings, goslings and other non-fledged birds due to direct exposure; and lethal or sub-lethal effects due to direct ingestion of oil or ingestion of contaminated foods (e.g., insect larvae, mollusks, other invertebrates or fish).

Marine mammals in the Colville River Delta, lower Nigliq Channel, Harrison Bay, and possibly the nearshore Beaufort Sea have a greater probability of exposure to oil in VLVSs than in small to large ones for the same reasons birds do. Even a VLVS (unless it approaches millions of gallons) from the CPAI Development Plan or the FFD is unlikely to affect bowhead whales or other marine mammals outside Harrison Bay.

Terrestrial mammals could be affected over several acres to tens or hundreds of acres in a VLVS, (especially of oil). They would tend to avoid oiled areas and thus lose a measurable though small proportion of available forage habitat. The risk of direct contact with oil and thus potential injury or death increases over that of small to large spills. Most of the larger mammals could avoid the oiled area. The loss of vegetation from oil and/or salt water spills is measurable but would not constitute a substantial portion of the available forage.

SOCIAL/CULTURAL/ECONOMIC ENVIRONMENT

The economy, socio-cultural, and cultural aspects of the North Slope could be affected by a VLVS. A VLVS of oil that enters the Colville River from CD-3 or for the FFD, from HP-4, HP-7, HP-12, HP-13, HP-14, or pipelines joining these pads, would likely affect the commercial fish populations and/or the Helmericks fishing gear for at least one fishing season and maybe longer if it directly affected the fishery areas (Section 3.3.2.5 for discussion of the commercial fishery). This could close the fishery resulting in the loss of jobs and income for the family.

VLVSs could generate many additional jobs depending upon where the spill occurs. Onsite workers doing other operations and other response personnel from the North Slope including trained responders from the Barrow and Nuiqsut response teams, as well as other locations in Alaska, would conduct the initial responses. A VLVS of oil that enters the flowing water, especially where the oil strands along a substantial stretch of shoreline or riverbank, could require the temporary employment of additional labor to clean up the oil. Some of this labor would come from the North Slope population while much of it would come from outside contractors, spill response organizations, and other sources identified in the CPAI ODPCP.

Effects on the socio-cultural systems of local communities could come from interference with subsistence-harvest patterns from both the physical impacts of VLVS of oil and oil-spill cleanup as well as stress due to fears of a potential spill and the disruptions it would cause. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed for at least an entire season and possibly longer if there are concerns over the tainting of fish and other subsistence resources or potential displacement of subsistence resources and hunters. If a VLVS contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. The overall effects from these sources are not expected to displace ongoing socio-cultural systems but these systems could be disrupted for several years.

Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and disrupt some socio-cultural systems; however, it would probably not displace these systems. The sudden employment increase could have sudden and abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup of a VLVS is unlikely to add population to the communities because administrators and workers would live in separate enclaves. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs.

A VLVS (especially of oil) could affect certain types of cultural resources if they are near water bodies and above the ground surface (e.g., hunting camps). The type and location of cultural resources usually are clearly identified before construction of a facility so that the cultural resources would not be affected by most spills or by subsequent spill cleanup. Although cleanup from these spills might be more invasive because of the non-frozen surface environment, there is little chance that either the spill or cleanup would affect cultural resources. Because the occurrences of most of the surface and subsurface cultural resources near the facilities are documented, the probability of impact is low.

VLVSs of oil or salt water could affect up to several hundred acres of the habitat for subsistence species such as caribou or waterfowl, particularly those in remote sections of the pipelines or in the larger rivers and creeks. The direct and indirect impacts to the subsistence species are likely to be limited to the immediate area of the spill and could have a duration up to several years after the spill. Most of the motile subsistence resources (e.g., birds, mammals, and fish) would move to adjacent unaffected areas and some of the subsistence users would likely follow the resources. From a technical “protection of human health” perspective, the resources may meet all government agency regulations regarding safety for ingestion or dermal contact in a relatively short time after the spill has been cleaned up. For all resources, the perception of contamination in the absence of testing (e.g., abscesses, pus spots, discoloration, anatomical deformity, and taste) or the tested presence of contaminants at levels deemed acceptable by the government may still discourage subsistence resource users from harvesting and consuming the resource for multiple harvest seasons (i.e., several years). If harvesters perceive the resource habitat or traditional harvest location to be contaminated, they may go further from the community or traditional harvest location to harvest uncontaminated resources (Fall and Utermohle 1999). Possible results of this change may be shifts in species emphasis, the need to purchase some formerly subsistence foods to reinforce perceptions of safety, and the need to expend more time, effort, and money pursuing resources at more distant locations with greater commensurate accident risks for some modes of travel (Fall and Utermohle 1999, Fall et al. 2001).

A VLVS would result in a major response and cleanup effort, especially for a spill that is in habitat remote from the ice or gravel structures. The response could include the presence of hundreds of humans, boats, and aircraft that would displace subsistence species and alter or reduce access to these species by subsistence hunters. This impact would last as long as the major response activity continues, probably no longer than two seasons, and generally less than one.

A VLVS that reaches a creek or river (including the Nigliq Channel) in the break-up to initial freeze-up season could move rapidly downstream. The spilled material (especially oil) could be visible and thus could have a short-term (and possibly long-term) impact on recreation values. Fishing, boating, camping, scenic values, and other recreation pursuits could be impacted as a result of an oil spill in a riverine environment that is used by recreationists. The obvious short-term effects would be the oil residues in areas of use. The long-term effects would possibly be the reduction or loss of fishing and the diminished scenic value of the area, as oil residue could take a long time to weather to the point it is not detectable. A VLVS of salt water is likely to have less short-term impact on recreational uses because salt water is less visible than oil. However, a salt water spill could affect the fish, birds, and, over a longer period, vegetation, which could affect the recreational value and use of these resources.

A VLVS spill requiring a large contingent of cleanup personnel and equipment cleanup on the tundra, especially on a creek or river, or a large tundra lake, could have a temporary impact on the viewshed.

4.3.5 MITIGATION MEASURES

Most of the “mitigation measures” focus on prevention of spills or the rapid and efficient containment and cleanup of those spills that do occur. Most of these measures are incorporated into the design and operation/maintenance procedures for the oilfield and are described in Section 2. They include a detailed ODPCP that would be prepared by CPAI for the project facilities as they are constructed and put into production.

Additional mitigation measures to reduce the probability of a spill, reduce the volume potentially spilled, or decrease response time include:

- Install automatic shutdown isolation valves, or vertical loops in the salt water and diesel pipelines on each side of the major creek or river crossings. These crossings include Nigliq Channel (except in Alternative D), Ublutuoch River, and Tamayayak Channel in the CPAI Development Plan. For the FFD, additional crossings could include Fish-Judy Creeks, Kalikpik River, and the Colville River (if an additional Sales Oil line is required). These valves should be capable of automatic shutdown and closure from a remote location (e.g., APF-1), as well as manual closure. The goal is to minimize the amount of spilled material that might enter these rivers and creeks in the event of a leak, and especially in the event of a complete pipeline rupture.
- In Alternatives A through C, conduct regular and frequent visual inspection of the pipelines on the bridge crossing the Nigliq Channel during break-up floods, especially in the larger flood events (e.g., greater than or equal to a 50-year flood level). The inspection would identify any potential problems with the integrity of the bridge because of ice jams, erosion and scour, etc., as well as determine if there are additional risks of pipeline failure and a need to reduce or stop flows until integrity is assured. These inspections would be more frequent than the routine inspections of the pipeline system already included in Section 2.

An additional recommendation is to require that CPAI and other potential operators in the FFD scenario collaborate with the appropriate state, federal, and Native government agencies to evaluate the benefits of and need for conducting a basic monitoring program for each spill that reaches the wet or dry tundra and/or water bodies including tundra ponds, tundra lakes, creeks, rivers and estuaries. The primary goal would be to determine (1) the type, magnitude, and duration of detectable community and population-level impacts from the spilled material, as well as the cleanup actions, and (2) the recovery process of the impacted habitats and measurably affected resources. The details regarding duration, areal extent, parameters to measure, and other elements of a monitoring program would be developed on a case-by-case basis. The resulting information would be made publicly available, probably on a current web site. The purpose for this information would be to provide a more quantitative basis than exists at present for evaluating impacts of future potential and actual spills on the North Slope and to evaluate the benefits and costs of natural and anthropogenic restoration processes.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

SECTION 4A
DIRECT AND INDIRECT IMPACTS – ALTERNATIVE A

4A.1 INTRODUCTION

This section provides an analysis of the environmental consequences that would result from implementation of Alternative A – CPAI Development Plan and FFD.

The CPAI Development Plan includes five production pads, CD-3 through CD-7. Produced fluids would be transported by pipeline to be processed at APF-1. Gravel roads would connect CD-4 through CD-7 to CD-1. CD-3 would be accessed by ice road or by air. Gravel used for construction of roads, production pads, and airstrips would be obtained from the existing ASRC Mine Site and Clover. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. CD-3 would be the only new production pad with an airstrip. CD-6 would be within a 3-mile setback from Fish Creek from which the BLM’s ROD for the Northeast National Petroleum Reserve-Alaska IAP/EIS (Stipulation 39[D]) prohibits permanent oil facilities (BLM 1998b). This alternative would provide for an exception to this provision to allow for the location of CD-6, and its associated road and pipeline, within the setback. Additional exceptions would be required to locate oil infrastructure within 500 feet of some water bodies (Stipulation 41), and to allow roads connecting to a road system outside the National Petroleum Reserve-Alaska (Stipulation 48). Aboveground pipelines would be supported on VSMs and would be at elevations of at least 5 feet above the tundra. Powerlines would be supported by cable trays placed on the pipeline VSM, except for one powerline suspended from poles between CD-6 and CD-7.

Alternative A – FFD includes two hypothetical APFs and 22 hypothetical production pads in addition to the five production pads proposed under Alternative A. Gravel roads would connect all but six production pads. Five production pads in the lower Colville River Delta (CD-3, HP-7, HP-12, HP-14, and HP-15), and one near the Kogru River (HP-22) would be designed with airstrips for access, instead of roads. Construction and operation strategies described for the applicant’s proposed action would apply for Alternative A – FFD. Exceptions to the stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS and ROD would be necessary to allow placement of facilities in certain areas.

4A.2 PHYSICAL CHARACTERISTICS

4A.2.1 Terrestrial Environment

4A.2.1.1 Physiography

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON PHYSIOGRAPHY

CONSTRUCTION PERIOD

Impacts to physiography would result from changes to landforms by construction of roads, production pads, airstrips, and gravel mines. Impacts would be localized to the immediate footprint of the facilities and gravel mines and their immediate surroundings. Surface terrain would change because of placement of gravel roads and production pads. Placement of gravel on the tundra for roads, production pads, and airstrips creates a raised terrain feature that would directly affect physical characteristics, such as thermal regime and hydrology, if not properly accounted for in the design. As an example, if the thickness of the road embankment is not adequate to maintain thermal stability, then the permafrost below the road could begin to melt, creating thaw subsidence (thermokarsting) adjacent to the road. This would lead to settlement of the roadbed, subsequent structural failure, and increased ponding (Frederick 1991).

New gravel mine sites, including the proposed Clover Potential Gravel Source, would affect the existing tundra surface by requiring the complete removal of surface vegetation, and overburden and extraction of the underlying gravels in a fashion similar to the existing ASRC Mine Site. Depending on site-specific conditions, a large disturbance such as this could cause melting of the permafrost soils around the mine site perimeter, which would create additional landform changes. Gravel mining leaves a large hole in the ground. This could result in the creation of shallow and deep water habitats. If ponds are created, they would likely be much deeper than a typical North Slope lake, and as is normal under a water body that does not freeze completely during winter, thaw bulb formation likely would follow.

Gravel mines could affect about 65 acres. Areas that would experience direct physiographic effects from placement of gravel on the tundra include 241 acres.

OPERATION PERIOD

Compared to the landscape that would be altered by original construction, the operational phase of the facilities would have relatively little effect on landforms. Maintenance grading of the surfaces of production pads and roads would modify the surface, but the general shape of the road and production pads would be the same throughout the life of the facilities.

Snow accumulations from wind drifting and snow plowing would increase the meltwater runoff or ponding in areas adjacent to roads and production pads, where utilized gravel fill or overburden placed on the tundra surface would impede the downslope movement of water. Some impedances simply increase soil moisture content on the upslope side of the barrier, while others create ponds. Ponds could dry up during the summer, or they could become permanent water bodies that persist from year to year and thus potentially disturb gravel structures (Walker et al. 1987a, Walker 1996). Project design aspects intended to reduce these effects include orienting production pads to minimize wind drift accumulations, using the natural slope or culverts to alleviate ponding, and depositing snow for removal in designated areas, which would limit ponding during the summer melting period (Frederick 1991).

ABANDONMENT AND REHABILITATION

Upon abandonment, Clover would become a small lake (Appendix O). If land management agencies require the removal of roads or production pads at other sites, Clover is a likely location for the disposal of resulting gravel (the rehabilitation plan may need to be altered if gravel is placed back into the pit [Appendix O]), particularly of that on the west side of the Nigliq Channel. Roads and production pads left in place upon abandonment could remain in place for many decades, particularly in drier areas. In areas that have soils with high ice content, such as at CD-3, the production pads may gradually subside into thermokarst troughs. (BLM and USGS 1992). Complete removal of roads and production pads in these ice-rich areas could result in ponding or other grade alterations from thaw subsidence (Kidd et al. 2004).

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PHYSIOGRAPHY

The ASRC Mine Site and Clover would experience direct physiographic effects from gravel mining operations. Areas that would experience direct physiographic impacts from the tundra gravel placement and mining include 306 acres for Alternative A and 1,608 acres for Alternative A – FFD.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON PHYSIOGRAPHY

Impacts to physiography would occur primarily during the construction phase and would be a consequence of changes to landforms during and after construction of roads, production pads, airstrips, and mine sites. If not properly designed and constructed, these resulting landforms could adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PHYSIOGRAPHY

No measures have been identified to mitigate impacts to physiography under Alternative A – CPAI Development Plan or Alternative A – FFD. Adverse impacts to the physiography from gravel mines can be indirectly mitigated by rehabilitation of the mine site to produce a net positive to the affected area by providing either fish or waterfowl habitat (see Appendix O).

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PHYSIOGRAPHY

There were no stipulations identified in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding physiography, and there are no potential mitigation measures developed in this EIS.

4A.2.1.2 Geology

Plan Area geology is comprised of marine limestones and marine and deltaic sands and shales of Mississippian to mid-Createceous age (Gyrc 1985), mantled largely by Quaternary-aged fluvial and glaciofluvial sediments (Rawlinson 1993). Oil production efforts in the Plan Area target a Jurassic sandstone reservoir located in the Beaufortian Sequence (BLM 2003b).

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON GEOLOGY

CONSTRUCTION PERIOD

Direct Effects

Drilling oil production wells at the five production pad locations (CD-3 through CD-7) would directly impact the physical integrity of reservoir and overlying bedrock by pulverization and fracture. The only surface bedrock identified in the Plan Area outcrops at the bend in the lower Colville River, upstream of Ocean Point (Mayfield et al. 1988). Alternative A does not propose excavation activities in this area, and would therefore not directly impact surface bedrock. The volume of rock impacted by drilling is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during construction would produce no measurable effect and are considered negligible under this alternative.

Indirect Effects

No indirect effects are recognized for the construction period.

OPERATION PERIOD

Direct Effects

Annular disposal or injection of Class I and II wastes would directly impact the receiving bedrock via possible propagation of existing fractures, increase of pore space pressure, and alteration of pore space composition within an approximately 0.25-mile radius of the injection well (40 CFR 146.69 (b)). The volume of rock impacted by waste disposal is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during operation would produce no measurable effect and are considered negligible under this alternative.

Production of petroleum hydrocarbons from subsurface reservoirs constitutes an irreversible and irretrievable commitment of resources. Direct impacts to petroleum hydrocarbon resources in the Plan Area would be major under Alternative A.

Indirect Effects

No indirect effects are recognized for the operation period under Alternative A – CPAI Development Plan.

ABANDONMENT AND REHABILITATION

Geology would not be impacted by abandonment activities under Alternative A – CPAI Development Plan.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON GEOLOGY

Direct and indirect impacts incurred during construction and operation of Alternative A – FFD would be similar to those presented for Alternative A – CPAI Development Plan in Section 4A.2.1, but would be experienced over greater spatial and temporal extents. Direct impacts to Plan Area bedrock would remain negligible under Alternative A – FFD. Direct impacts to Plan Area petroleum hydrocarbon reserves would be major under the Alternative A – FFD.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON GEOLOGY

Under either Alternative A or Alternative A – FFD, development scenario the irreversible and irretrievable commitment of petroleum hydrocarbon resources constitutes a major impact, however petroleum hydrocarbon production is the purpose of the project. Impacts to bedrock under either alternative would be negligible.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR GEOLOGY

Mitigation of impacts to petroleum hydrocarbons would be in conflict with the purpose of the applicant's proposed action. Therefore no measures have been identified to mitigate impacts to geological resources under Alternative A or Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR GEOLOGY

There were no stipulations identified in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding geology, and there are no potential mitigation measures developed in this EIS.

4A.2.1.3 Soils and Permafrost

The thermal regime of permafrost is the dominant control on soil formation and soil properties on the Arctic Coastal Plain. Problems associated with oil field development in the continuous permafrost zone stem from alteration of ground temperatures by construction and operation of oil production infrastructure. Destructive thermokarst often results where permafrost melting occurs in ice-rich, fine-grained sediments (Truett and Johnson 2000, Walker et al. 1987a).

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SOILS AND PERMAFROST

CONSTRUCTION PERIOD

Direct Effects

Direct effects on soil and permafrost that would occur during Alternative A – CPAI Development Plan's construction period include gravel excavation, placement of fill on tundra, ice road and ice pad construction, tundra travel, and culvert, VSM, and power pole installation.

Gravel excavation/blasting would occur during the winter and would require overburden removal and storage on an ice pad adjacent to the pit. Overburden would be replaced before break-up and recontoured following pit closure. Gravel excavation constitutes a loss of overburden and active layer soils, alters local hydrology, and causes erosion and landscape scarring (Meehan 1988).

The estimated volume of gravel required for construction under Alternative A – CPAI Development Plan is 20 million cy. As a basis for rough estimates of mine pit areas, extrapolations can be made from the conditions and overburden depths experience gained during Phase I (1999 and 2000) of ASRC Mine Site operations. About 35,000 cy of material per acre were extracted at the site (TMA 2000). Thus, extraction of the subsurface gravel required for construction of Alternative A – CPAI Development Plan would impact approximately 65 acres of tundra at Clover (Appendix O).

Ice pads may be constructed adjacent to active material sources to stockpile overburden. The impacts of ice pads to the underlying soil and permafrost would likely be greater than those sustained from ice roads, due to the greater and constant weight of overburden. However studies quantifying the impacts were not identified for this evaluation. Overburden extends to approximately 22 feet at the ASRC Mine Site (TMA 2000) and is estimated to range from 6 to 20 feet at Clover (Appendix O). Assuming an average overburden thickness of 16 feet and that 1 acre of ice pad would be required for each 25,000 cy of overburden (TMA 2000). Ice pads would cover a maximum 267 acres of tundra under Alternative A – CPAI Development Plan.

The construction of gravel pads, roads, and airstrips requires a thickness of fill equal to or greater than the depth of summer thaw. Addition of fill effectively increases the insulating capacity of the active layer and prevents destructive thaw settlement (NRC 2003, Brown et al. 1984). Placement of fill on tundra constitutes a direct loss of the underlying soil and alters active layer properties and surface hydrology (Hanley et al. 1980). Compaction of vegetation and soil at the edge of fill provides greater heat conductivity and has been shown to cause subsidence parallel to road beds (Auerbach 1997). The damming effect of fill creates impoundments and diverts surface water flow along the edge of fill (Auerbach 1997, Hanley et al. 1980). Assuming a depth of fill is 5 feet for roads and airstrips, 5 to 6 feet for production pads, and further assuming a 2:1 side-slope on all fill, gravel would overlie approximately 241 acres of tundra under Alternative A – CPAI Development Plan.

Temporary ice roads and ice pads would be constructed to stage and transport materials and equipment, to access drill sites, and to construct pipelines, gravel roads, bridges, and overhead powerlines. Although thaw settlement could result if the ice road compaction of vegetation appreciably decreased the insulating capacity of the active layer (Felix et al. 1992), investigations addressing ice road impacts show that impacts are confined to the vegetative layer (Walker et al. 1987b). One, 2 and 24 years after abandonment, no significant variation in active layer depths was found across the traces of 1-year ice roads on the North Slope (BLM 2002, Payne undated). In addition, a pilot study conducted west of Nuiqsut concluded that no significant difference in active layer depth existed between a 2-year and 1-year ice road (Yokel et al. undated). Temporary ice roads and adjacent ice pads would cover a total of 1,449 acres of the Plan Area over six winter construction seasons under Alternative A – CPAI Development Plan, assuming the following conditions exist:

- A standard ice road width of 40 feet
- Placement of a 150- by 300-foot ice pad every 0.5 miles along ice roads for pipeline construction
- Placement of a 800- by 800-foot ice pad on either side of the proposed seven bridge sites

Winter tundra travel would occur during construction in order to pre-pack ice roads, transport gravel, and construct pipelines and overhead powerlines. Winter tundra travel permits allow operation of low-pressure (less than 4 psi) vehicles only and requires a 12 inch depth of frost and 6 inches of snow cover. When low-pressure vehicles are used, winter travel does not appear to adversely affect soil and permafrost. The difference in thaw depth between tundra disturbed by 400 passes of 20 Rolligon tractor-trailers (low-pressure vehicles) on a North Slope winter trail and undisturbed tundra was not significant (Roth et al. undated). The miles of temporary winter trails required for construction under Alternative A – CPAI Development Plan is circumstantial, and is therefore difficult to estimate.

The installation of culverts, VSMs, and power poles all involve ground disturbance and therefore have similar impacts on soil and permafrost. Excavation and drilling required for installation alter soil properties and destroy the overlying vegetative mat. Loss of the insulating vegetation, soil compaction, and installation of dense infrastructure can increase heat flux to the subsurface.

To preserve natural drainage patterns, roads would be culverted for all alternatives. Culvert installation involves excavating across the roadbed to a depth 2 feet below the bottom of fill, placing bedding material, laying the culvert, and backfilling with gravel (McDonald 1994). The passage of air and water through culverts placed in the active layer would introduce heat into the subsurface during the summer and could potentially degrade permafrost. Conversely, culverts not filled with snow in the winter would be poorly insulated from the winter cold and may allow permafrost to aggrade (Brown et al. 1984). Assuming culverts are placed every 500 feet, and that the average width and depth of a culvert trench in tundra soil is 5 and 2 feet, respectively, 280 culverts would be placed, consequently disturbing approximately 5,800 cy of soil.

Installation of VSMs and power poles are proposed to carry power cable and fiber-optic cables between production pads. Placement of VSMs would utilize drilling and slurry backfill techniques. Borings 20 to 25 feet-deep and spaced 55 feet apart would be drilled directly from an ice road for the installation of VSMs. Assuming an average boring diameter of 26 inches, 3,418 VSMs would be installed and would disturb approximately 12,200 cy of soil under Alternative A. Alternative A proposes suspension of an overhead powerline on poles between CD-6 and CD-7. Power cables would be carried in a VSM cable tray between all other production pads. Borings for power pole installation would be two feet in diameter, approximately 15.5 feet-deep, and spaced 250 feet apart. Under Alternative A, 137 power poles would be installed and installation would disturb approximately 250 cy of soil. Heaving of both VSMs and power poles due to active layer freeze and ice lens formation has been a reoccurring problem in northern regions. The integrity of the VSM or power pole is affected when heave results from the failure of permafrost soil to adfreeze to the pile (Nottingham and Christopherson 1983).

Wastewater and water discharged to the tundra could originate from temporary camps and hydrostatic pipeline testing, respectively. Temporary camps would be necessary to support the construction and drilling activities under either alternative. All project pipelines would undergo hydrostatic testing before operation. Domestic wastewater from these camps could be disposed of through onsite annular injection, by hauling to the Alpine wastewater system, or by treatment and discharge to the tundra. Fresh water used for hydrostatic testing of pipelines would be tested for contaminants, filtered, and subsequently discharged onto the tundra. Discharge of wastewater or test water during the frozen season could create sheet ice that would increase soil moisture levels following the spring melt. Discharge during the nonfrozen season could cause soil erosion and create impoundments. Discharge to the tundra of both domestic wastewater and water used for hydrostatic testing is allowed under a General NPDES Permit. The volume of wastewater discharged to the tundra would be dependant on the number of personnel housed in temporary camps, the duration of camp use, and the method of disposal chosen. The volume of test water discharged to the tundra would be dependant on the type of water used (fresh or salt) and the volume of water required. Because of these variables, the volume of water discharged to the tundra is difficult to estimate.

Indirect Effects

The primary indirect effect of impacts to soil and permafrost sustained during the construction period is permafrost degradation. The construction activities most likely to initiate permafrost degradation are gravel excavation, the placement of fill on tundra, and culvert installation. Where permafrost degradation occurs in ice-rich sediments, thermokarst would likely result (Truett and Johnson 2000, Walker et al. 1987a). Permafrost degradation and thermokarst are considered indirect impacts due to their delayed manifestation and potential to propagate from the original area of impact. Discussion and estimates of potential thaw settlement for geomorphic units in a portion of the Plan Area are provided in Section 3.2.1.3.

The degree and extent of permafrost thaw and thermokarst initiated by gravel excavation largely depends on the hydrological condition of the pit following its closure. The modification of surface topography accompanying gravel excavation often alters natural drainage patterns, and results in the creation of impoundments or of flowing water which may thermally and hydraulically erode sediments (Walker and Walker 1991, IPASC 2003). If the pit is flooded by either natural drainage or human action to a depth greater than 6 feet, geologic material at the lake bottom would remain unfrozen year-round, allowing formation of a thaw bulb (talik) in the soils below the lake base. If depth of flooding is less than 6 feet, the lake and lake bottom soils would freeze each winter (NRC 2003). Degradation of local permafrost would still occur in this scenario due to the lower albedo and greater heat absorption of water relative to the original vegetation, but less permafrost melting would occur than that associated with thaw bulb formation (Walker et al. 1987a). If the pit does not flood and overburden is not replaced before break-up, exposure of mineral sediments to summer heat would increase the active layer depth at the expense of permafrost.

The placement of fill on tundra impounds and diverts surface water flow and intercepts drifting snow. Klinger et al. (1983b) reported that snowbanks within 39 feet of the West Road at Prudhoe Bay were 5 to 10 times deeper than the natural snowpack. Greater than normal accumulations of plowed or drifted snow increases local soil moisture levels (Brown et al. 1984). Ponding and channeling of surface water flow along the edge of fill (Auerbach 1997, Hanley et al. 1980) increases heat flux to the subsurface, can initiate thermokarst, and would erode surface sediments (Walker et al. 1987a, Walker 1996). Relative to dust and snowbanks, flooding was determined to be the most spatially-extensive impact at West Road (Klinger et al. 1983a). Impoundments cover an area more than twice the area of initial gravel placement in a heavily developed portion of the Prudhoe Bay Oilfield (Walker et al. 1987b).

Roadbeds constructed for Alternative A would be culverted to preserve natural patterns of surface flow to the extent possible. When improperly placed, culvert function is compromised and can potentially expand the area and extend the duration of spring flooding (Walker et al. 1987b). Culverts placed during winter construction, as is proposed for this project, often misjudge the location and elevation of natural drainages and thus do not completely drain the upgradient side of the road. Blockage of seasonal floodwaters may be compounded by the presence of late-melting snow and ice in culverts or the bowing of culvert ends above the level of impounded water. Culvert bowing is caused by greater thaw settlement along the centerline of the road relative to road margins; differential thaw settlement is likely due to inadequate compaction of frozen road and culvert bedding material (Brown et al. 1984). Wind-generated wave action in the temporary impoundments of floodwater can erode the roadbed and sudden release of floodwater may result in washouts (McDonald 1994, Brown et al. 1984).

The effects of water discharge to the tundra are not well defined. If water discharged to the frozen or nonfrozen tundra is eventually or immediately impounded, enhanced absorption of summer heat by active layer soils could initiate thermokarst. Active layer changes resulting from winter tundra travel and VSM and power pole installation represent minor thermal impacts that permafrost soils could sustain without thermokarst.

OPERATION PERIOD

Direct Effects

The operation phase would result in no additional physical disturbance to the ground surface. However, permafrost degradation and thermal and hydraulic erosion initiated during the construction phase would continue and possibly become more severe (Hanley et al. 1980). Direct effects on soil and permafrost that would occur during the operation period include: dust fallout, snowplowing, gravel spray, tundra travel, transmission of warm reservoir fluids, sub-permafrost injection of waste, and accidental oil spills.

Dust generated from vehicle travel decreases the albedo of roadside snow and increases the alkalinity of the underlying soil (Walker et al. 1987b). In turn, the lower albedo of dust-coated snow initiates early melt and allows for greater cumulative absorption of radiation by the active layer. Increase in the alkalinity of soil adjacent to roads diminishes the vigor of acidophilus moss species and thus the insulating capacity of the vegetative mat (Auerbauch 1997). On roads with minimal winter traffic, snowdrifts do not receive much dust and melt about 2 weeks later than the surrounding tundra (Klinger et al. 1983b). Late-melting snow provides greater insulation to the underlying permafrost (Auerbauch 1997).

Snowplowing and road-grading may spray gravel onto the tundra. Thin deposits of fill on dry tundra lower the surface albedo and stimulate plant growth by increasing soil temperatures. An increase in plant growth may eventually lead to greater insulation of the active layer. Alternatively, thick deposits of gravel would compact or kill vegetation (Truett and Johnson 2000). Greater heat conductivity and the decreased albedo of thick gravel, relative to intact vegetation, would increase the active layer depth.

Summer and winter tundra travel would occur during the operation period for maintenance and repair of infrastructure, for response to oil spills and other emergences, to facilitate ice road construction, or for transport to roadless sites. Travel by low-pressure vehicles during the summer is allowed by special permit only, however exceptions are made for emergency situations. The regulations for, and impacts associated with, winter travel via low-pressure vehicles are the same as those previously described under direct effects for the construction period. Low-pressure vehicle travel in the summer produces a greater impact than winter travel and varies in accordance with vegetation type and the number of vehicle passes. Wet tundra is most vulnerable to low-pressure vehicle impacts and a concentration of low-pressure vehicle traffic on a limited number of tracts produces the most noticeable impact (Walker et al. 1987b). The miles of summer trails required for pipeline maintenance and oil spill response is partially dependant on the proper functioning of infrastructure, and is therefore difficult to estimate.

The passage of warm oil, gas, and produced water through oil wells results in the conduction of heat to surrounding permafrost ground. Up to 32 oil wells with 20-foot well head spacing are proposed at each of the five production pads (CD-3 through CD-7) for a total of 160 oil wells. At the Alpine Development Project, thawing caused by the passage of 109°F fluids is slowed by a combination of passive heat pipes (thermo-siphons) and insulated conductor pipe installed to 50 and 80 feet, respectively. Similar refrigeration technology is proposed for Alternative A. Despite these mitigation measures, annular thaw below the refrigerated interval would gradually expand and coalesce with zones of annular thaw from neighboring wells (NRC 2003).

Disposal of hazardous and non-hazardous waste, or oil and gas production wastes, would occur by injection into Class I Hazardous, Class I Non-Hazardous, or Class II injection wells, respectively. Similar to the production of reservoir fluids, injection of warm waste slurry would raise the temperature of permafrost ground adjacent to the well-casing. Warming of the permafrost base above the receiving reservoir has also been documented (NRC 2003). Class I Non-Hazardous and Class II wells exist at APF-1. Alternative A – CPAI Development Plan proposes installation of at least one additional Class II disposal well. Specific production pads have not yet been identified for installation of injection wells.

The accidental release of oil to the ground surface alters soil and active layer properties. Three years after the addition of crude hydrocarbons to wet soil in Barrow, soil pH shifted toward neutral and the infiltration rate and availability of plant cations were decreased. These trends were attributed to the absorption of hydrocarbons into soil organic matter (Everett 1978). The degree of impacts on soil and permafrost by oil is dependant on the thermal condition of the ground at the time of the spill and on moisture levels in nonfrozen receiving soils (Walker 1978). Release of oil to snow or frozen tundra produces a larger area of impact, due to enhanced lateral movement of oil over the frozen surface (Collins et al. 1993). However, oil is easier to clean up and would be less likely to impact vegetation, soil, and permafrost under Alternative A, due to the retarded penetration into frozen ground (Truett and Johnson 2000). Penetration of oil at water-saturated sites would be minor. Oil spilled onto saturated soil would disperse as thin film, allowing lighter components to volatilize (Walker et al. 1987b). Because volatilization of oil at saturated sites is enhanced, recovery of vegetation takes less than 10 years, whereas recovery at dry sites may take twice or three times as long. Impacts on soil and permafrost by potential oil spills is conjectural and cannot be quantified, however Truett and Johnson (2000) report that, historically, relatively few oil spills in North Slope oilfields have contacted and killed tundra vegetation. By extension, impacts to soils and permafrost would be minor.

Indirect Effects

The primary indirect effects of impact on soil and permafrost sustained during the operation period would be permafrost degradation. Where permafrost degradation occurs in ice-rich sediments, thermokarst is the likely result (Truett and Johnson 2000, Walker et al 1987a). Estimates of potential thaw settlement for geomorphic units in the Plan Area are provided in Section 3.1.1.3. Permafrost degradation and thermokarst are considered indirect impacts due to their delayed manifestation and potential to propagate from the original area of impact.

Accumulations of plowed and drifted snow, dust fallout, loss of insulating moss, and thick deposits of gravel spray contribute to roadside thermokarst. Several studies have found that the depth of active layer thaw was significantly deeper adjacent to Prudhoe Bay roads than they were at greater distances from the roads (Haag and

Bliss 1982, Webber et al. 1985, Walker and Everett 1987, Auerbach 1997). Webber et al. (1985) and Walker and Everett (1987) also documented ice wedge melting and the subsequent conversion of low-center polygons to high-center polygons along Prudhoe Bay roads. Indirect impacts due to dust fallout and changes to moisture and thermal regimes were quantified by creating a 164-foot buffer (Hettinger 1992, BLM and MMS 1998a, 2003b) in the ArcView 8.3 GIS application around the outside of the gravel fill. Based on these calculations, the estimated area of thermal impact under Alternative A is 1,152 acres.

Compaction and exposure of vegetation and soil by low-pressure vehicles operating in the summer have been shown to cause thermokarst under certain conditions. In general, the impact of summer tundra travel by low-pressure vehicles is dependant on hydrological and permafrost conditions. The trace of a single Rolligon's pass through wet tundra could not be located 7 years after the disturbance. However, tracks from ten passes of Rolligons depressed the wet tundra surface by 5.9 to 7.9 inches and produced collapse features 11.8 inches-deep where the tracks crossed ice wedges. Persistence of thermokarst features indicates thermal equilibrium had not been achieved in the 7-year period following the disturbance (Walker et al 1987b).

Transmission of warm production fluids and waste slurries through the permafrost interval cause permafrost melt adjacent to the well-casing, and can potentially cause well-bore and well-house subsidence. It is estimated that annular thaw would advance upward to 40 feet bgs and cause an eventual thaw settlement of 12–24 inches at the ground surface (NRC 2003). Waste injection would have the additional impact of degrading the base of permafrost. Sub-permafrost injection of waste at Prudhoe Bay Pad 3 was shown to cause warming in the bottom 150 feet of permafrost (NRC 2003).

The increased albedo and reduction of plant cover caused by oil spills alters the thermal regime of the active layer and may cause thermokarst (Truett and Johnson 2000). The depth of thaw in soils impacted by a 6-year old crude oil spill from the TAPS at Franklin Bluffs was 39 inches greater than average thaw depth in undisturbed tundra (Walker et al 1985). Similarly, Everett (1978) reports 28 years after a spill at the Fish Creek test well site vegetation had recovered little, strong diesel odors persisted, and thaw depth was significantly deeper beneath the spill. Petroleum contamination persists in the arctic due to the low rates of biodegradation and volatilization.

Thermal impacts to permafrost are exacerbated by recent increases in high-latitude air temperatures. If correlative trends in permafrost warming continue, permafrost temperatures would increase 2°F at coastal sites and 5.4°F at inland sites over the 20-year life of the project. Because the temperatures of Arctic Coastal Plain permafrost are low (19.8°F to 15.6°F) (Romanovsky and Osterkamp 1995) permafrost can sustain substantial warming before actual melt occurs.

ABANDONMENT AND REHABILITATION

Soils and permafrost would be negligibly impacted by removal of aboveground facilities at CD-3 (pipelines, bridges, and power poles), assuming that they are removed during winter. Removal of aboveground facilities at CD-4 through CD-7 also would have negligible impacts on soils and permafrost. If production pads and roads are maintained, soils and permafrost would remain unaffected. Once maintenance of the roads and production pads is stopped, thaw subsidence in ice-rich areas will result in settling of the gravel structures into thermokarst troughs. Removal of the roads and production pads would accelerate the thaw subsidence, but would also accelerate the reclamation process.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SOILS AND PERMAFROST

Direct and indirect impacts incurred during construction and operation of Alternative A – FFD would be similar to those presented for Alternative A – CPAI Development Plan, but would be incurred over greater spatial and temporal extents. Alternative A – FFD infrastructure would extend to the Plan Area boundary and construction would occur over a 20-year period. The volumes, areas, and distances listed below were calculated under the same assumptions presented for Alternative A. but do not include the impacts quantified for Alternative A's infrastructure and activities.

Alternative A – FFD would place 8.8 million cy of gravel over 1,262 acres of tundra. Gravel excavation required for Alternative A – FFD would disturb 346 acres of tundra and would require 358 acres of ice pad for stockpiled overburden. Temporary ice roads and ice pads associated with construction and staging would cover a total of 2,575 acres over 20 winter seasons. Because the number of bridges required for construction of Alternative A – FFD was not determined, the area of ice roads and adjacent pads does not include ice pads associated with bridge construction. Installation of 1,300 culverts and 14,411 VSMs would disturb 27,000 and 51,400 cy of soil, respectively. Additional overhead powerlines are not proposed for Alternative A – FFD. This alternative would construct two HPFs (HPF-1 and HPF-2) and 22 HPs, in addition to the five production pads (CD-3 through CD-7) proposed under Alternative A – CPAI Development Plan. Up to 32 oil wells are proposed at each HP. Alternative A – FFD would include both Class I and Class II disposal wells at each HPF, and additional Class II disposal wells at the HPs. Specific production pads have not yet been identified for the installation of injection wells under Alternative A – FFD. Assuming 704 oil wells and four waste injection wells are constructed for FFD, impacts to permafrost would be approximately four times those incurred under the Alternative A – CPAI Development Plan. Due to the hypothetical nature of Alternative A – FFD, impacts due to tundra travel, bridge construction, and discharge of water to the tundra could not be estimated.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SOILS AND PERMAFROST

Placement of fill on the tundra and the construction and operation of roads represent the greatest impacts on Plan Area soils and permafrost, respectively. Impacts that increase heat flux to ice-rich permafrost can initiate thermokarst and compromise the integrity of overlying or adjacent infrastructure. Impacts to Plan Area soil and permafrost resources would be unavoidable and semipermanent.

Alternative A would place gravel or ice over approximately 1,757 acres of soil, disturb approximately 2 million cy of soil via gravel excavation and the placement of infrastructure, and thermally impact 1,152 acres of tundra. The surface area of soil impacted both directly and indirectly under Alternative A represents approximately 0.2 percent of the total Plan Area, which is an inconsequential impact.

Alternative A – FFD would place gravel or ice over approximately 4,195 acres of soil and disturb approximately 8.8 million cy of soil via gravel excavation and the placement of infrastructure. The surface area of soil impacted both directly and indirectly under Alternative A – FFD represents approximately 1.2 percent of the total Plan Area. This area includes the disturbance associated with both direct and indirect impacts, however, it does not account for disturbance of ice pads for bridge construction.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SOILS AND PERMAFROST

Soil and permafrost systems could recover to their pre-impact state but not without appropriate mitigation. Because impacts to soil and permafrost are generally unavoidable, mitigation measures aim to minimize the degree and magnitude of the action.

Impacts associated with gravel excavation and placement of fill on the tundra are minimized by reducing the gravel footprint required for the ASDP. The need for gravel can be decreased by reducing road miles and by recycling drill cuttings for use as fill. If reducing the volume of gravel required for construction is not possible, then sequential mining with the replacement of overburden in previously excavated areas is recommended to rectify impacts to local soil and permafrost (Meehan 1988). Revegetation of gravel mine sites restores the insulative capacity of the active layer and allows reaggradation of permafrost where melt has occurred. Irrigation and natural recolonization of tundra plant species is the most effective method of rehabilitation for physically-disturbed sites where some soil remains. Providing that soil overburden is returned to the excavation, diversion of water into the pit would speed the natural colonization of vegetation, thereby improving soil structure and insulating permafrost (Walker et al 1987b). Mineral soil or bedrock (at the base of upland mine sites) and areas of thick gravel fill (such as roads, pads, airstrips) are environments that are too hostile for natural recolonization of most tundra plant species (Jorgenson 1997), and thus would remain barren unless more aggressive rehabilitation measures were initiated (Meehan 1988). These aggressive rehabilitation measures could include topsoil application, gravel removal (for areas of fill only), surface manipulation for moisture enhancement, nutrient addition, and/or plant cultivation (Jorgenson 1997).

Impacts on soil and permafrost associated with the construction and operation of roads can be minimized by placing a sufficient thickness of fill, carefully considering road alignment, culverting, dust control, and snow blowing. A thickness of fill greater than the maximum depth of summer thaw is necessary to prevent melting of the subgrade (NRC 2003). Alignments across ice-rich sediments, natural drainages, and acidic tundra with abundant Sphagnum species should be avoided to reduce the alteration of natural surface water flow, the need for culverts, and the potential for thermokarst (Auerbach 1997). Where the placement of fill would impede drainage, culverts should be placed and maintained so that they are capable of handling flooding (Klinger et al. 1983b). To ensure that culverts completely drain the upgradient side of the road, culvert locations should be determined under conditions of maximum flow prior to road construction, and culvert blockages should be removed or prevented. Culvert maintenance could include annual clearing of snow and ice blockages, placement of an end cap in the fall and removal of the cap before break-up (McDonald 1994, Brown et al. 1984), or installation of steam pipes in culverts to reduce flooding (Klinger et al. 1983b). Because pads and airstrips cannot be culverted (Meehan 1988), they should be oriented parallel to natural drainages and to the direction of prevailing wind to avoid impoundments and accumulations of drifted snow (Meehan 1988). Where alignment of high-traffic roads through sensitive tundra cannot be avoided, chip-seal surfacing, periodic watering, or application of hydroscopic chemicals such as Calcium Chloride ($CaC1_2$) is recommended to control dust (NRC 2003, Meehan 1988, Walker and Everett 1987). The impact of gravel spray on permafrost is minimized by electing to blow snow instead of plowing it. The impacts of ponding caused by snowbank melt can be minimized by designating contained areas for cleared snow.

Impacts associated with placement of infrastructure can be mitigated by selecting an alternative that minimizes the miles of pipeline and powerline required and avoids placing VSMs and/or power poles in ice-rich sediments. Alternatives that shorten the route of pipelines and powerlines would require less VSMs and power poles for construction, and would thus disturb a smaller volume of soil. Similarly, running power cable in a tray supported by pipeline VSMs would eliminate the need to construct a separate powerline or to bury power cable. VSM and power pole jacking can be minimized by avoiding clays and coarse-grained material (which have characteristically low adfreeze bond strengths), and by placing VSM or power poles at least twice as deep as the maximum summer thaw (Nottingham and Christopherson 1983). To prevent well-bore and well-house subsidence, thermo-siphons and insulated conductor pipe should be installed.

Impacts resulting from water discharge onto the tundra would be avoided if the water generated by temporary camps is hauled to the APF-1 for treatment or disposed of onsite by injection. Onsite injection of hydrostatic pipeline test water would also be permissible if sea water was used instead of fresh water. If wastewater and hydrostatic test water are released to the tundra, impact to soil and permafrost would be minimized by targeting terrain that is sloped enough to allow drainage of water, but is not so steep that soils are eroded. Controlling discharge flow and protecting the tundra surface would further minimize erosion.

To avoid impacts of tundra travel on soil and permafrost it is best to restrict travel to winter months, when impacts extend to the vegetative mat only. If summer travel is necessary, measures to minimize impacts include limiting traffic, avoiding tight turns, using different paths to disperse disturbance, and following the shortest path from origin to destination (Jorgenson et al. 1996).

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SOILS AND PERMAFROST

The Northeast National Petroleum Reserve-Alaska IAP/EIS stated that emphasis should be focused on maintaining the thermal properties of the existing vegetation and surface organic mat, or substituting other thermal insulation. In particular, replacing topsoil, removing gravel fill, and in some cases reseeding, would be effective mitigation measures to accomplish this goal. In addition, reducing erosion by diverting runoff from exposed surfaces, and taking measures to reduce overland flow velocities, would be effective measures in reducing soil and permafrost impacts.

4A.2.1.4 Sand and Gravel

Once used, sand and gravel resources utilized for road, production pad and/or airstrip construction could only be available for re-use upon abandonment.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SAND AND GRAVEL

CONSTRUCTION PERIOD

The estimated volume of gravel needed for Alternative A is 2 million cy. ASRC has a gravel mining and restoration plan already in place for their pit. The restoration plan for Clover is presented in Appendix O. Impacts to sand and gravel are similar to those discussed in Section 4A2.1.3 Soils and Permafrost. The primary construction activities consist of removing sand and gravel for road and production pad construction.

OPERATION PERIOD

During the operation period, small amounts of gravel are expected to be extracted from existing permitted mine sites for repair of road and production pad embankments (for example, if a washout occurs).

ABANDONMENT AND REHABILITATION

Abandonment will not impact sand and gravel unimpacted by construction. The sand and gravel in production pads, roads, and airstrips that are left in place will gradually become unavailable for re-use in ice-rich areas as it settles into thermokarst troughs. If the BLM Authorized Officer (AO) determines that the gravel cover should be removed, it could be used for other development in the area, or returned to the pits from which it was extracted. Returning gravel to pits may require alteration of mine rehabilitation plans. Contaminated sand and gravel in the production pads would not be re-used, but treated and disposed of in an approved manner.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SAND AND GRAVEL

Alternative A – FFD would utilize and expand on the same road network that would be constructed under Alternative A – CPAI Development Plan. Alternative A – FFD, depicted in Figure 2.4.1.2-1, is estimated to require 8.8 million cy of gravel (see Tables 2.4.1-6 and 2.4.1-7). With the exception of the potential use of Clover, the source of this gravel has not yet been determined.

If alternative embankment designs, such as use of insulation in embankments, are used under Alternative A – FFD (see Section 2.3.1.1), less sand and gravel would be affected.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SAND AND GRAVEL

Once used, sand and gravel utilized for road, production pad and/or airstrip construction could only be available for re-use upon abandonment. Removal of gravel fill is not currently a scheduled element of abandonment activities.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SAND AND GRAVEL

No measures have been identified to mitigate impacts to sand and gravel resources under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SAND AND GRAVEL

Stipulations 32 and 40 of the Northeast National Petroleum Reserve-Alaska IAP/EIS would reduce impacts associated with the sand and gravel operations for the applicant’s proposed action. Stipulation 32 minimizes the amount of utilized gravel by minimizing the number of production pads and roads between them, integrating facilities (such as an airstrip with a road) as much as possible, and implementing gravel saving technologies, such as insulated or pile-supported production pads. Stipulation 40 reduces the effects of gravel mining by prohibiting mining in the active flood plain of a river, stream, or lake, and by restricting the number of new sites to the minimum necessary for efficient development. This current EIS has not identified any additional mitigation measures

4A.2.1.5 Paleontological Resources

Paleontological resources are nonrenewable. Once they are adversely impacted or displaced from their natural context, the damage is irreparable.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON PALEONTOLOGICAL RESOURCES

Because paleontological resources are not ubiquitous within the Plan Area as are habitat and wildlife, it is quite possible that the applicant's proposed action would have no impact on paleontological resources, simply because the activities would occur where paleontological resources are not present (BLM and MMS 1998a). The only known paleontological sites within the Plan Area are found outside of areas likely to be disturbed by the applicant's proposed action, with the heaviest concentration of known fossil localities in the vicinity of Ocean Point, on the bank of the Colville River, approximately 13 miles southwest of Nuiqsut. Places of particular concern are those areas that have bluff exposures.

CONSTRUCTION PERIOD

The likelihood of affecting surface paleontological materials within the Plan Area is low because of their isolated and rare occurrence.

The primary source of potential impacts to paleontological resources would result from the excavation of sand and gravel material at the ASRC Mine Site and at Clover. Disturbance at the ASRC Mine Site would occur within the permitted footprint. Surface disturbance at Clover would encompass approximately 65 acres (Appendix O). Extraction of sand and gravel from these sites could affect paleontological resources.

Drilling of as many as 150 production wells could occur under Alternative A. Resulting subsurface disturbance would be limited to the annulus of the well-bore itself. It is unlikely that drilling would affect important, accessible paleontological material.

Pipelines and overhead powerlines would be constructed during the winter months from ice roads and pads. Therefore, the only impact resulting from pipeline and powerline construction would be associated with the placement of approximately 3,418 VSMs and the potential placement of power poles between CD-6 and CD-7. Vehicle bridges at river crossings would be constructed during the winter months from ice roads and pads. Therefore, the only impact resulting from bridge construction would be associated with placement of sheet piling at bridge abutments, and foundation piles at abutments and in-stream locations. Because route surveys are required for all construction activities, the location of important archaeological and paleontological resources would be known and their disturbance would be avoided.

OPERATION PERIOD

No additional impacts to paleontological resources are expected during the operation period unless infrastructure is expanded (for example, pads are expanded or bridges are widened).

ABANDONMENT AND REHABILITATION

Paleontological resources will not be impacted by abandonment activities.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PALEONTOLOGICAL RESOURCES

Under the Alternative A – FFD, the mechanisms associated with impacts to paleontological resources would remain the same as those described under Alternative A. However, the larger extent of the development would increase the intensity of the actions. The primary potential cause of impacts would be excavation of gravel on approximately 346 acres. Approximately three gravel mine sites would be developed to provide the volume of construction material necessary for Alternative A – FFD. The location of the gravel mine sites is unknown, but could potentially be sited so as to result in affects on paleontological resources. It is likely that the additional sand and gravel mine sites would be situated in the vicinity of the Fish–Judy Creeks Facility Group and/or the Kalikpik–Kogru Rivers Facility Group. In addition, approximately 1,262 acres could be covered by gravel during the construction of pads, roads, and airstrips.

ALTERNATIVE A–SUMMARY OF IMPACTS (CPAI AND FFD) ON PALEONTOLOGICAL RESOURCES

Surface activities, such as the construction of pad, road, and airfield embankments, are not likely to affect paleontological resources. Impacts could result from activities involving subsurface disturbance, such as sand and gravel mining. Installation of VSMs, power poles, and bridge piles would occur only after route surveys had been conducted, so important paleontological resources would be known and avoided. Excavation of sand and gravel (under approximately 65 acres for Alternative A and 346 acres for Alternative A – FFD constitute the greatest risk to paleontological resources. This “greatest risk” represents inconsequential impact potential to paleontological resources.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PALEONTOLOGICAL RESOURCES

No additional measures have been identified to mitigate impacts to paleontological resources under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PALEONTOLOGICAL RESOURCES

Stipulation 74 of the Northeast National Petroleum Reserve-Alaska IAP/EIS requires surveys for cultural and paleontological resources prior to any ground disturbing activities. This stipulation ensures that resources are noted and that appropriate avoidance or collection measures are taken. No additional mitigation measures are identified in this EIS.

4A.2.2 Aquatic Environment

4A.2.2.1 Water Resources

This section consists of four main parts: an introduction to general concepts regarding impacts to water resources, a description of the impacts to water resources during construction, a description of the impacts during operations, and last, a description of Alternative A – FFD in relation to water resources issues. The construction and operation discussions within each part are structured similarly, as follows: impacts to subsurface waters are described first, followed by impacts to surface waters, and lastly, impacts to the nearshore and estuarine environment.

Within the surface waters discussion, construction impacts are discussed in the following order: those associated with water supply demands, those associated with water withdrawals, those related to roads and pipelines, and those associated with pads.

Within the operational impacts section, six major topics are discussed in the following order: 1) impacts to subsurface water, 2) impacts to lake hydrology, 3) hydrologic analyses and modeling to assess effects of facilities and structures, 4) impacts to surface waters associated with facilities and structures, 5) impacts to the nearshore and estuarine environment, and 6) impacts associated with ice conditions during break-up. At the end of the water resources section, a summary of impacts is included and followed by a section describing mitigation measures (including monitoring), and the effectiveness of protective measures.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON WATER RESOURCE QUANTITIES AND PHYSICAL PROCESSES

Potential impacts to water quantities and physical processes associated with groundwater, surface water (lakes and streams), estuaries, and the nearshore environment could result from construction and operation activities associated with Alternative A. Elements that could affect water resources include gravel roads, ice roads, pipelines, production pads, bridges, culverts, airstrips, gravel pits, groundwater well reinjection activities, and water supply extraction (for potable water and construction use). Potential impacts would typically fall into one or more of the following categories:

- Shoreline disturbance and thermokarsting
- Blockage or convergence of natural drainage
- Increased stages and velocities of floodwater
- Increased channel scour
- Increased bank erosion
- Increased sedimentation
- Increased potential for overbank flooding
- Removal or compaction of surface soils and gravel, and changes in recharge potential
- Produced water spills
- Demand for water supply

CONSTRUCTION PERIOD

Table 4A.2.2-1 summarizes potential construction impacts to water resources in the general vicinities surrounding CD-3 through CD-7, including the roads and pipelines connecting the facilities. The table also provides qualitative indicators of whether a particular impact may occur to a specific water resource (i.e., groundwater, lakes, streams, etc.), but does not provide a measure of likelihood. The potential type of impacts listed above are numbered from 1-10, and shown at the bottom of the table for each type of facility/project component (i.e., gravel road, production pad, etc.). If an impact is indicated, it is understood that appropriate best management practices (BMPs) and design features will be incoporated to reduce the likelihood of specific impacts.

Impacts to Subsurface Water During Construction

As described in Section 3.2.2.1, North Slope groundwater resources are rare but are primarily shallow. Sparse data indicates that sub-permafrost groundwater is brackish to saline, rendering it non-potable. The permafrost forms an aquiclude that prevents the mixing of sub-permafrost and supra-permafrost groundwater. Therefore, deep groundwater injections are not expected to affect the quality or quantity of shallow groundwater.

Injection well permits and aquifer exemptions are issued by the USEPA and the AOGCC and take into consideration UIC regulations under the SDWA. UIC regulations are designed to protect all underground sources of drinking water. Thus, until proven otherwise, groundwater zones are assumed to be potential drinking water resources. UIC regulations define an underground source of drinking water as any aquifer that:

- Contains a sufficient quantity of groundwater to supply a public water system
- Contains fewer than 10,000 mg/L total dissolved solids
- Is not an exempted aquifer

The USEPA retains ultimate authority to exempt water in aquifers from this UIC criteria (USEPA 2004).

The State of Alaska, upon receipt of a Class II permit application may submit a request for approval of an aquifer exemption to the USEPA Region 10. An aquifer exemption may be determined to be a minor or substantial revision of the State's program. After consultation with the USEPA Region 10, an exemption may be considered if the USEPA concurs with the findings of the State of Alaska that an underground source of drinking water exists (40 CFR §144.3) and that specific criteria for an aquifer exemption (40 CFR §144.7 and §146.4) are met. To date, the USEPA has not made a determination that aquifers in the vicinity of the applicant's proposed action meet the UIC's criteria for an exemption.

In order to dispose wastes in a USDW, an operator must obtain an aquifer exemption from the USEPA and/or AOGCC. Three types of injection well permits are relevant to the applicant's proposed action: a one-time use (annular injection during drilling activities), a Class I Well, and a Class II Well permit. During the drilling phase of a wellfield, operators may dispose of drilling wastes (e.g. mud and cuttings that originated from down hole sources) one time, without obtaining additional class permits. Non-hazardous wastes associated with oil and gas exploration, domestic wastewater, non-hazardous wastes, stormwater, and other non-exploration and production materials can be injected into a Class I Well. Only non-hazardous wastes from downhole associated with oil and gas exploration and production can be injected into a Class II well. As with the one-time annular injection, the drilling wastes approved for injection are those that originated from down hole sources. Non-hazardous domestic wastewater can also be injected into a Class II Well, with approval from AOGCC, if it is intended to enhance oil recovery (USEPA 2004).

The drilling wastes that would be produced as a result of the applicant's proposed action from construction of the proposed wellfields could be disposed of into Class I and Class II Wells at CD-1. However, rather than haul the drilling wastes to CD-1, it may prove more practical to dispose of the wastes via annular disposal at the drilling sites. Class I and Class II Wells would be installed at the production pads as they are needed. Injecting drilling waste into deep groundwater zones would represent an insignificant impact since the potential injection zones likely contain non-potable resources, the sub-permafrost groundwater does not mix with supra-permafrost groundwater, and the deep groundwater would not be extracted for construction activities.

Water in shallow taliks or local supra-permafrost zones could be affected during the construction, operation, and rehabilitation of any gravel mine. These zones could be enlarged or eliminated by the removal of shallow surface soils, blasting and excavation of gravel, and rehabilitation of the site. Rehabilitation would include allowing natural flows to fill the mine site excavation, and then allowing the shallow zones to recharge naturally (Appendix O). In general, the construction of CD-3 through CD-7 could temporarily affect shallow subsurface water (or the hyporheic zones that exist as thaw bulbs around lakes and streams) and could temporarily change the thickness and vertical location of the active thaw zone in the immediate vicinity of each gravel mine. Impacts would be highly localized.

Impacts to Surface Waters During Construction

Impacts Associated with Water Supply Demands During Construction.

Lakes will supply fresh water for the construction of ice roads and pads during the winter construction months. Potential uses of the water include: for hydrostatic testing of newly-installed pipelines, for potable water at temporary construction or drilling camp facilities, for mud-plant operations during drilling, and for other maintenance activities. Long-term (more than 1 year) effects on lake water levels are not expected because natural annual recharge processes sufficiently recharge the lakes (Michael Baker, Jr. Inc. 2002). While some lakes have been found to have subsurface connections between adjacent lakes (USFWS 2003), whereby water withdrawals from one lake might lower the level of an adjacent lake, this effect would likely be short-lived, also due to the annual recharge processes. Pre- and post-lake level monitoring would be required to verify these impact predictions.

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES

Alternative A – CPAI Development Plan

CD-3 and Vicinity

	Groundwater		Lakes		Major and Minor Stream Crossings					Estuaries and Nearshore Environment	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta Mouth	Harrison Bay
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI	NI	7	NI
Ice Roads	NI	NI	8,10	8,10	2,3	NI	NI	NI	2,3	2,3	NI
Airstrip	8	NI	NI	NI	2,3,4,5	NI	NI	NI	NI	6	NI
Pipeline Segment: CD-1 to CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	NI	1,2,3	6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

CD-4 and Vicinity

	Groundwater		Lakes		Major and Minor Stream Crossings		Estuaries and Nearshore Environment
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Colville River Delta including the Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment from CD-1 to CD-4	8	NI	NI	NI	2,7	2,3,4,5,6	NI
Ice Roads	NI	NI	8,10	8,10	NI	2,3	NI
Culverts and Culvert Batteries	NI	NI	2	2	2,3,7	2,3,4,5,6,7	NI
Pipeline Segment from CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	8	NI	NI	1,2,3,4,5,6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

<table>
<tr><th colspan="9">Alternative A – CPAI Development Plan</th></tr>
<tr><th></th><th colspan="2">Groundwater</th><th colspan="2">Lakes</th><th colspan="3">Major and Minor Stream Crossings</th><th>Estuaries and Nearshore Environment</th></tr>
<tr><th colspan="9">CD-5 and Vicinity</th></tr>
<tr><th></th><th>Shallow Groundwater</th><th>Deep Groundwater</th><th>Small Shallow Lakes and Ponds</th><th>Large Deep Lakes</th><th>Nigliq Channel</th><th colspan="2">Minor Streams</th><th>Harrison Bay</th></tr>
<tr><td>Gravel Road Segment: CD-2 to CD-5</td><td>8</td><td>NI</td><td>NI</td><td>NI</td><td>2,3,4,5,6,7</td><td colspan="2">2,4,5,6</td><td>NI</td></tr>
<tr><td>Ice Roads</td><td>NI</td><td>NI</td><td>10</td><td>10</td><td>NI</td><td colspan="2">2,3</td><td>NI</td></tr>
<tr><td>Pipeline Segment: CD-2 to CD-5</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>2,7</td><td colspan="2">6</td><td>NI</td></tr>
<tr><td>Production Pad</td><td>8</td><td>NI</td><td>8</td><td>NI</td><td>NI</td><td colspan="2">2</td><td>NI</td></tr>
<tr><td>Bridges/Culverts (e.g., Nigliq Crossing)</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>2,3,4,5,6,7</td><td colspan="2">2,3,4,5,6,7</td><td>6</td></tr>
<tr><td>Groundwater Wells</td><td>9</td><td>9</td><td>NI</td><td>NI</td><td>NI</td><td colspan="2">NI</td><td>NI</td></tr>
<tr><td>Surface Water extraction for potable and construction use</td><td>NI</td><td>NI</td><td>10</td><td>10</td><td>NI</td><td colspan="2">NI</td><td>NI</td></tr>
<tr><th colspan="9">CD-6 and Vicinity</th></tr>
<tr><th></th><th>Shallow Groundwater</th><th>Deep Groundwater</th><th>Small Shallow Lakes and Ponds</th><th>Large Deep Lakes</th><th>Fish–Judy Creek Basin</th><th>Ublutuoch River Basin</th><th>Minor Streams</th><th>Harrison Bay</th></tr>
<tr><td>Gravel Road Segment: CD-5 to CD-6</td><td>8</td><td>NI</td><td>5,6</td><td>NI</td><td>NI</td><td>2,3,4,5,6,7</td><td>2,3,4,5,6,7</td><td>NI</td></tr>
<tr><td>Ice Roads</td><td>NI</td><td>NI</td><td>10</td><td>10</td><td>2,3</td><td>2,3</td><td>2,3</td><td>NI</td></tr>
<tr><td>Pipeline Segment: CD-5 to CD-6</td><td>NI</td><td>NI</td><td>5,6</td><td>NI</td><td>NI</td><td>2,7</td><td>2,7</td><td>NI</td></tr>
<tr><td>Production Pad</td><td>8</td><td>NI</td><td>8</td><td>NI</td><td>NI</td><td>NI</td><td>2</td><td>NI</td></tr>
<tr><td>Bridges/Culverts</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>2,3,4,5,6,7</td><td>2,3,4,5,6,7</td><td>6</td></tr>
<tr><td>Groundwater Wells</td><td>9</td><td>9</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td></tr>
<tr><td>Surface Water extraction for potable and construction use</td><td>NI</td><td>NI</td><td>10</td><td>10</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td></tr>
</table>

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – CPAI Development Plan							
	Groundwater		Lakes		Major and Minor Stream Crossings		Estuaries and Nearshore Environment
CD-7 and Vicinity							
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish–Judy Creek Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to CD-7	8	NI	2	2	2,3,4,5,6,7	2,3,4,5,6,7	NI
Ice Roads	NI	NI	10	10	2,3	2,3	NI
Pipeline Segment: CD-6 to CD-7	NI	NI	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	2	NI
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Notes:
1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural drainage
3 = Increased stages and velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over-banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

The water demand during construction and maintenance of ice roads is expected to be approximately 1 million gallons [or 3.1 acre foot (ac-ft)] of water per mile of constructed ice road. The estimates for the periods of ice road construction provided in Section 2.4.1.1, indicate that annual demands for lake water could range from 16 to 67 million gpy (or 50 to 208 ac-ft/yr) over the 6 years of ice road construction needed to complete the project infrastructure. The estimated maximum annual water demand for ice road construction is roughly similar to the annual water demand of 2002 (64.7 million gallons) (Table 4A.2.2-2). As explained below, this represents only 3 percent of the total permitted lake volume. Water withdrawals are usually made from the nearest or largest permitted lakes along the route. Because it is sometimes difficult to pre-determine which lakes will be used for ice road development, permitting of additional lakes could be needed in the future. Prior to lake withdrawals, lake monitoring studies are recommended for each lake to evaluate the possibility of affecting habitats and recharge potentials.

Approximately 38,000 gpd, or 3.5 ac-ft per month, of water would be required to support drill rig and mud plant operations at each production pad location, and an additional, 5,000 gpd, or 0.46 ac-ft per month, of potable water would be used by the drilling camp until drilling is complete. Thus, activities at each pad would consume approximately 1.3 million gallons per month (4 ac-ft per month). Fresh water also would be used during any additional drilling or fire-fighting activities over the long-term. Fresh water might also be used to conduct hydrostatic testing of newly constructed pipelines, although it is likely that other sources (i.e., sea water, salt brines) will also be used. Based on preliminary analyses, a 12-inch pipeline would require about 5.9 gallons of fluid per foot of pipeline and a 24-inch pipeline would require about 23.5 gallons per foot. Testing will be conducted over short segments (likely no more than a few thousand feet) and the test fluid would be reused in successive subsections. Thus, the total fluid volumes needed for testing are rather small (i.e., about 12,000 gallons for 2,000 feet of a 12-inch line, or 47,000 gallons for 2,000 feet of a 24-inch line) compared to other needs. This volume is expected to be very small compared to the overall water demand associated with ice-road construction and other activities during the construction period.

Recent Monitoring of Impacts to Lakes Associated with Water Withdrawals

The ADNR regulates water withdrawals from any surface or subsurface water bodies such as those that may be utilized by the applicant’s proposed action. In addition, as part of the National Petroleum Reserve-Alaska stipulations, minimum lake water depths associated with total permitted volumes for extraction have been established by the ADF&G, including sustained withdrawal, based on surface water flow during spring break-up events (see Table 4A.2.2-2). National Petroleum Reserve-Alaska Stipulation 20 limits the time and volumes of water withdrawals from lakes, as described below:

- No water will be withdrawn from rivers and streams during winter.
- No water will be withdrawn during winter from lakes less than 7 feet-deep if they are connected with, or subject to, seasonal flooding by a fish-bearing stream.
- Water may be withdrawn from isolated lakes less than 7 feet-deep that are not connected with, or subject to, seasonal flooding by a fish-bearing stream.
- Water withdrawals may be authorized from any lake less than 7 feet-deep if it is demonstrated that no fish exist in the lake.
- Water withdrawal during winter from lakes 7 feet-deep or deeper will be limited to not more than 15 percent of the estimated free-water volume (i.e., excluding the 7 feet of ice).
- Operators are encouraged to use new ice construction methods (e.g., aggregate “chips” shaved from frozen lakes) to decrease water demands, construction time, and impact on fisheries.
- Water withdrawals may be authorized for a drawdown exceeding 15 percent from a lake deeper than 7 feet when it is demonstrated that no fish exist in the lake.

TABLE 4A.2.2-2 2002 NATIONAL PETROLEUM RESERVE-ALASKA LAKES WATER WITHDRAWAL VOLUMES FROM ALL WATER SUPPLY DEMANDS

Lake	Location	Total Gallons Permitted	Total Pumped Volume Jan–May 2002 (Gallons)						Rank	Percent Used of Total Permitted
			January	February	March	April	May	Total		
R0052	Hunter	1,520,000	628,220	222,000	315,000	117,000	18,000	1,300,220	12	86.00
R0053	Hunter	24,000,000	9,000	0	0	0	0	9,000	16	0.04
R0054	Hunter	23,690,000	990,192	0	0	0	0	990,192	15	4.00
R0056	Hunter	339,670,000	3,426,474	444,000	330,000	0	0	4,200,474	5	1.00
L9911	Rendezvous	463,590,000	0	1,226,744	0	0	0	1,226,744	13	0.30
L9804	East National Petroleum Reserve-Alaska	106,860,000	87,990	2,441,376	0	0	0	2,529,366	8	2.00
L9806	East National Petroleum Reserve-Alaska	262,980,000	8,277,528	526,907	113,400	0	0	8,917,835	3	3.00
L9817	Peak Camp	72,150,000	2,400,696	10,330,410	3,444,060	1,115,106	0	17,290,272	1	24.00
M9602	Colville	415,900,000	2,479,428	358,971	0	0	0	2,838,402	7	0.70
M9605	Colville	238,300,000	3,336,228	303,450	1,687,350	1,001,700	56,700	6,385,428	4	3.00
M9606	Colville	3,900,000	476,322	596,232	0	0	0	1,072,554	14	28.00
M9912	Mitre	27,610,000	0	9,112,176	919,800	0	0	10,031,976	2	36.00
M9915	Rendezvous	23,360,000	0	297,360	1,158,780	0	0	1,456,140	10	6.00
M9922	Spark/Mitre	175,890,000	0	3,126,807	217,728	0	0	3,344,535	9	2.00
M9923	Spark/Mitre	175,890,000	0	3,126,807	217,728	0	0	3,344,535	6	2.00
M0183	Puviaq	2,000,000	0	0	0	1,405,800	27,000	1,432,800	11	72.00
Total		**2,290,070,000**						**64,664,442**		**3.00**

Source: Michael Baker Jr. Inc. 2002e

Table 4A.2.2-6 summarizes the volumes of water withdrawn from permitted lakes within the Plan Area during the winter of 2002 and shows the percentage of used volume relative to total permitted lake volume. The data indicate that for each lake the proportion of pumped-to-permitted lake volume was highly variable (ranging from 0.3 to 86 percent) during the 2002 exploration season, but the total lake volume used from all lakes combined was only 3 percent (Michael Baker Jr. Inc. 2002e) of the total available permitted volume. In a related study, MJM Research (2002) concluded that, in addition to determining the maximum extractable volumes, the water withdrawals did not affect fish populations or water quality.

Michael Baker Jr. Inc. (2002e) conducted monitoring and recharge studies of lakes in the Plan Area that were designed to evaluate the impacts associated with water withdrawals for ice road/pad construction during exploration activities. The studied lakes included five pump lakes: L9911, L9817, M9912, M9922, and M9923, and four reference lakes: L9807, L9823, M0024, and M9914. Site visits were conducted so that that lake conditions during pre-pump, post-pump, post-break-up, and pre-freeze-up periods could be measured.

The results of the study indicate that impacts to lake water levels were offset annually by natural recharge processes that occurred primarily during spring break-up. Table 4A.2.2-3 presents estimates of recharge for the nine lakes studied by Michael Baker Jr. Inc. (2002e). The table also presents the volumes of water withdrawn from each pump lake and the difference between that volume and estimated recharge. The data indicate that all the pump lakes received spring recharge in excess of winter withdrawal volumes. Further, the estimated recharge and surplus volumes shown in the table did not account for the excess water that entered and subsequently exited the lake during the monitoring period. Thus, the reported recharge and surplus volumes are minimum amounts. It should be noted, however, that only two of the lakes received drawdowns approaching the limit of 15 percent below 7 feet (DNR 2003).

Impacts Associated with Water Withdrawals During Construction

Some broad-based conclusions regarding impacts associated with water withdrawal from lakes were found by the Michael Baker (2002e) studies, and were based on comparisons of results from their 2002 lake monitoring and recharge studies, as well as from other studies, data, and information about the North Slope. The study concluded that water surface elevations decreased in most lakes between pre-pump and post-pump sampling events, and the water surface elevations in most pump lakes were lowered more than those in reference lakes, where no pumping was conducted. These water level changes in pump lakes were almost certainly the result of winter water withdrawal. Further, water surface elevations in all lakes declined over the summer to levels below those measured during the pre-pump sampling event. These summer declines in water surface elevations were the result of lake outflow and/or evaporation. The water surface elevations in all lakes increased to well above the pre-pump levels as a result of recharge (from snowmelt and snowmelt runoff) during spring break-up. Michael Baker Jr. Inc. (2002e) concluded that, without exception, natural recharge volumes to pump lakes were sufficient to compensate for winter water withdrawals. Moreover, lake discharge to streams was not compromised by pumping. They concluded that lake discharge to streams was more related to the location and timing of ice road melting than pumping.

Overall, the results of the lake monitoring indicate that when adhering to permitted pump volumes from permitted lakes, impacts to lake water levels are short-term. Water monitoring programs should be continued and further developed for representative areas within the Plan area. Any program should measure lake water levels through time, provide estimates of recharge and surplus volumes, and document any observed changes of water quality parameters over time. These programs should also be integrated with assessments of impacts to lake habitat to determine if additional or more frequent monitoring is required and changes to pumping programs is warranted.

TABLE 4A.2.2-3 WATER WITHDRAWAL AND SPRING RECHARGE VOLUMES

Water Surface Elevation (ft)						Lake Area (acres)	Lake Volume[a] (millions of gallons)	Minimum Recharge Volume (millions of gallons)	Total Withdrawal[b] (millions of gallons)	Minimum Surplus Volume [c] (millions of gallons)
Lake	**Pre-Pump**	**Post-Pump**	**Breakup**	**Post-Breakup**	**Recharged[d]**					
Pump Lakes										
L9911	68.38	68.35	68.67	--	0.32	540	464.6	56.3	1.2	55.1
M9912	41.41	40.64	41.63	--	0.99	33	27.6	10.6	10.0	0.6
M9922	50.30	49.88	50.83	--	0.95	191	108.6	59.1	1.6	57.5
L9923	57.76	57.44	--	57.96	0.52	252	175.9	42.7	3.3	39.4
L9817	N/A	53.98	--	54.96	0.98	75	72.2	23.9	17.3	6.6
Reference Lakes										
L9807	28.39	28.40	28.65	--	0.25	94	83	7.7	0.0	7.7
L9823	24.95	24.88	25.31	--	0.43	5	6.4	0.7	0.0	0.7
M0024	57.09	56.95	57.26	--	0.31	139	108.8	14.0	0.0	14.0
M9914	47.07	47.16	47.56	--	0.40	127	106.8	16.6	0.0	16.6

Sources: Michael Baker Jr. Inc. 2002e, MJM Research 200b, PAI

Notes:

[a] Based on water surface elevation changes

[b] January–May 2002

[c] Recharge and surplus volumes are considered minimum amounts, as these values do not include recharge volumes that flowed into and subsequently out of the lakes.

[d] Recharged elevation is equal to the difference between the break-up water surface elevation and the post-pump water surface elevation.

The ADNR has authorized water withdrawals from the Colville River. Under-ice discharge in the vicinity of the ice bridge location has never been measured, but based on observations made by CPAI hydrologists, in mid-February the under-ice flow cross-sectional area at the bridge is on the order of 7,000 square feet. Under those conditions, even assuming a flow velocity of 0.1 fps (which is about what was measured during winter 2003–04), under-ice discharge is still about 700 cfs (about 315,000 gpm). This discharge is likely well above the rate at which the water would be withdrawn (CPAI, e-mail communication, 2004). Thus, the dynamic equilibrium of the channel is maintained and the depositional regime unchanged. At about the same time, a saltwater wedge begins moving upstream under the ice, past the icebridge crossing. Presence of this wedge is interpreted as a condition where flow has ceased and where pumping is no longer permitted.

Impacts Related to Roads and Pipelines During Construction.

Natural drainage patterns can be disrupted when activities associated with the construction of roads and pipelines block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Because construction of roads and pipelines will occur during the winter season, direct construction-related impacts to streamflow processes are negligible. However, as described above, as a result of ice road construction and subsequent ice road melting, more water will enter particular stream systems depending on their locations and the timing of melts, or it could enter its usual system by a different route.

The construction of permanent gravel roads will compact underlying soil and reduce the soil surface area available for infiltration. Such effects impact the recharge potential of the tundra soils during spring break-up on a local level. The delta-wide affect of reduced recharge would be negligible. An indirect effect of road and pipeline construction is the potential disturbance of soils, which would not be realized until break-up when erosion and subsequent sedimentation occur.

Impacts Associated with Pads During Construction

Natural drainage patterns can be disrupted when activities associated with pad construction block, divert, or impede flow during flooding episodes of active stream channels, ephemeral or seasonal drainages, or shallow water (overland) flow paths. However, because construction of pads will occur during the winter season, construction-related impacts related to flow processes are negligible. Soil compaction beneath the ice will occur, which affects the soil recharge potential. As with road construction, erosion and sedimentation processes could be increased due to the potential disturbance of soils, which would not be realized until break-up, when surface runoff processes begin and entrain loosened sediment from disturbed soils.

Impacts to Estuaries and the Nearshore Environment During Construction

No impacts to wave processes, erosion buffers, water quantities, or flow processes within the estuarine and nearshore environment are expected during winter construction. The Colville River Delta may be subject to increased sedimentation (but likely not measureable) as an indirect and delayed effect of bridge construction (i.e., when break-up entrains sediment left from construction activities) over the Nigliq Channel, Ublutuoch River channel, construction activities at CD-3, or other facilities being constructed across or close to drainages.

OPERATIONS PERIOD

Table 4A.2.2-4 summarizes potential operation impacts to water resources in the general vicinities surrounding production pads CD-3, CD-4, CD-5, CD-6, and CD-7, including the roads and pipelines connecting the facilities.

Impacts to Subsurface Water During Operations

Operational impacts to subsurface water are limited to activities that generate waste and require injection disposal. After pretreatment to meet existing permit requirements, the incremental volume of wastewater from the permanent-worker housing at CD-1 would be injected into the approved Class I Disposal Wells at CD-1.

TABLE 4A.2.2-4 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative A – CPAI Development Plan

	Groundwater		Lakes		Major and Minor Stream Crossings					Estuaries and Nearshore Environment	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3 and Vicinity											
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	5	NI	NI	NI	NI	NI	7	NI
Ice Roads	NI	NI	NI	5	NI	NI	NI	NI	NI	6	NI
Airstrip	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI
Pipeline Segment: CD-1 – CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

CD-4 and Vicinity	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment CD-1 to CD-4	8	NI	NI	NI	NI	2,3,4,5,6,7	NI
Culverts and Culvert Batteries	NI	NI	1,2,7	NI	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	8	NI	NI	2,3,4,5,6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI
CD-5 and Vicinity							
Gravel Road Segment: CD-2 toCD-5	8	NI	NI	NI	2,4,5,6	2,4,5,6	NI
Pipeline Segment: CD-2 to CD-5	NI	NI	NI	NI	NI	6	NI
Production Pad	8	NI	8	NI	NI	NI	NI
Bridges/Culverts (including Nigliq Crossing)	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Table 4A.2.2-4 Potential Operational Impacts To Water Resources (cont'd)

Alternative A – CPAI Development Plan								
	Groundwater		Lakes		Major and Minor Stream Crossings			Estuaries and Nearshore Environment
CD-6 Pad and Vicinity								
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish–Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-5 to CD-6	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Pipeline Segment: CD-5 to CD-6	NI	NI	NI	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	NI	NI	NI
Bridges/Culverts	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI
CD-7 Pad and Vicinity								
Gravel Road Segment: CD-6 to CD-7	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI	
Pipeline Segment: CD-6 to CD-7	NI	NI	NI	NI	2,7	2,7	NI	
Production Pad	8	NI	1,7,8	NI	NI	NI	NI	
Bridges/Culverts	NI	9	NI	NI	NI	2,3,4,5,6,7	NI	
Groundwater Wells	9	9	NI	NI	NI	NI	NI	
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	

Notes:
1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages & velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

There are no camps at the satellites during operations, only during construction and drilling activities. Class I Disposal Wells allow for the disposal of non-hazardous industrial wastes, stormwater, and certain wastes that are exempt under federal regulations (40 CFR 261(b)(5)). Domestic wastewater must be injected via a Class I Well unless it is beneficially used in a Class II EOR (enhanced oil recovery) well (with AOGCC approval). In addition the disposal of non-hazardous industrial wastes, stormwaters and other non-exploration and production-related wastes can only be disposed of into a Class I Well (with USEPA approval), and not into a Class II Well (USEPA 2004). Approximately 2,000 to 3,000 gpd (or 2.3 to 3.4 ac-ft/yr) of wastewater would be generated by pad operations. Since groundwater from these potentially affected zones is not potable and would not be extracted for operation activities, no impacts to groundwater are expected.

Impacts to Lake Hydrology During Operations

Impacts Associated with Water Supply Demands

During operations lakes would supply fresh water for: the periodic construction of ice roads and pads during the winter seasons, dust abatement on roads, pads, and airstrips during summer, potable water needs, and fire suppression and maintenance activities. The ice road demand will be much greater than the other three demands, which except for potable water needs, by their nature are short in duration and/or of small volume. The water demand for ice roads would be comparable, on a per-mile of ice road basis, to construction period demands. However, the length of ice roads to be constructed during operations would be much less [requiring approximately 10 million gallons per year (gpy)]. Long-term (more than 1 year) effects on lake water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes (Michael Baker, 2002e). Once construction and drilling are completed, the overall water demand would be reduced because of fewer miles of ice roads, lack of mud plant operations except for occasional well workovers, lack of hydrostatic testing, and lack of temporary camps.

As indicated for the construction period, the results of lake monitoring above indicate that with prudent lake level monitoring and adherence to pumping only permitted volumes, impacts to lake water levels would be short-term. Continued monitoring programs should measure lake water levels through time and provide estimates of recharge and surplus volumes. These programs should also be integrated with assessments of impacts to lake habitat to determine if additional or more frequent monitoring is required.

Impacts to Lake Recharge Conditions During Operations

The proposed gravel access road from the existing Alpine facilities to the proposed CD-4 production pad, referred to here as the CD-4 road, follows a naturally occurring topographic high (comprised primarily of a vegetated aelion-dunal complex) that is oriented essentially parallel to flows in the area. Lake 9323 is situated at the southern end of this ridge, and the proposed CD-4 production pad is south of this topographic high. The proposed road crosses through a narrow section of Lake 9323. A series of culverts are planned to maintain fish passage (i.e., keep the lake open, unobstructed, and supplied with a sufficient quantity of water to admit freely the passage of fish) within the lake. Recharge to Lake 9323 during breakup has been observed to occur by one of three possible scenarios depending on the ice-affected water surface elevations of various channels: 1) northward- and westward-moving overflow from the Niqliq Channel; 2) northwestward-moving overflow through Lake 9324 from the Sakoonang Channel; and 3) southward-moving overflow originally from the Sakoonang Channel and passing through the long and narrow southern portion of Lake 9525 (which occupies a paleochannel). The proposed road route through Lake 9323 is not expected to affect these recharge mechanisms as long as the culvert battery allows for a sufficient flow through Lake 9324 to maximize recharge potential during breakup (i.e., as is planned to maintain fish passage).

Impacts to Surface Water Conditions at Gravel Mines

Upon completion of gravel extraction activities from a mine site, the site would be rehabilitated. Rehabilitation could include knocking down any gravel piles to near tundra-grade, and development of a water reservoir suitable to support fish and wildlife habitats if feasible and appropriate. The potential exists to create fish habitat by reclaiming gravel mines, if they are sufficiently close to waterways. The existing ASRC Mine Site was not designed with post-operational fish habitat creation in mind. Converting the pits into fish habitat was deemed not feasible during the site's original permitting and thus is not part of its rehabilitation plan.

The proposed Clover A Mine Site is still in the planning stages and only preliminary characterization of the material source has been done. The rehabilitation plan (ABR and PN&D, 2004) calls for the creation of a high-value waterbird habitat from the gravel pit (Appendix O). Specifically, the plan proposes to create a mosaic of shallow-water habitat, aquatic grass marsh, and vegetated islands within the shallow-water area for waterfowl nesting. The area of the flooded mine pit is expected to be approximately 60 acres, with a maximum lake depth of over 50 ft. Over 50 percent of the area is expected to be greater than 30 ft deep. The large volume of water that will eventually fill the pit is expected to alter the thermal regime of the permafrost beneath and adjacent to the waterbody, which will preferentially impact the steep side slopes. Maintaining a stable water level within the excavated area, once mining activities cease, will be critical to the success of the rehabilitation. It is expected that the main source of recharge water will come from snow capture (through drifting), snowmelt, and through recharge from overbank flooding from the Ublutuoch River and an existing nearby ephemeral drainage during spring breakup.

The rehabilitation plan calls for two years of monitoring following the completion of the restoration design and after the rehabilitated pit has filled with water. Monitoring plans include inspecting of the pit margin for erosion and instability. This would also include any signs of inflow or outflow erosion. In general, any new surface water bodies created by mine pit excavation would be left to recharge naturally during high flows of natural streams and man-made channels during annual spring break-up floods. This process could be aided by placing upwind snow fences or soil berms to accumulate windblown snow and speed filling the water impoundments. Specific stipulations would outline desired rehabilitation goals for the site.

Hydrologic Analyses and Modeling to Assess Effects of Roads, Pads and Bridges

Two-Dimensional Modeling of Colville River Delta

A two-dimensional surface water model (the USGS' Finite Element Surface-Water Modeling System) (Froehlich 1996) was integrated with a pre- and post-processing software program (Brigham Young University's Surface Water Modeling System) (1994) to predict water surface elevations and velocities in the Colville River Delta. The model boundary conditions and parameter assumptions were originally developed in 1997 (Shannon & Wilson, 1997), and have since been modified with additional data for specific locations (e.g., the Nigliq Crossing, the CD-4 pad location, etc.). The open-water two-dimensional model has proven to be a reliable and integral tool to aid in the design of existing and proposed Alpine Development Project facilities, pads, and pipelines (Michael Baker 2002b). More recently additional modeling was conducted to evaluate potential hydrologic and hydraulic impacts of the proposed facilities (including new production pads on the Delta, the CD-4 road, the Nigliq Bridge and approach roads as well as the existing facilities and structures) (Michael Baker 2004a, 2004c and 2004h). The recent modeling has evaluated four Nigliq Bridge lengths (900-, 1,200-, 1,500- and 1,650-foot) under varying hydrologic conditions, and described how each would affect water surface elevation and velocity at existing and proposed oilfield facilities.

Model runs of the existing and Alternative A conditions predicted water surface elevations and velocities during the estimated 10-, 50-, and 200-year recurrence interval floods. These floods are represented by flows estimated to be 470,000, 730,000 and 1,000,000 cfs, respectively, at Monument 1. Monument 1 is located just upstream of the head of the delta and the split between the Nigliq and East channels. Based on the model set-up, channel and floodplain topography and various parameter assumptions, the model calculates the proportion of flow that would be conveyed down the East and Nigliq Channels, as well as the smaller distributary channels that fork off the East Channel. At the above modeled flows, the Nigliq is predicted to convey 92,100, 163,000 and 246,000 cfs (or 19.5, 22.3 and 24.6%, respectively, of the Monument 1 total flow (Michael Baker, 2004h).

Table 4A.2.2-5 is a compilation of site-specific results for two modeled scenarios (i.e., the existing and CPAI proposed conditions) as presented in the recent modeling report prepared by Michael Baker (2004a). The table provides predicted water surface elevations and velocities at thirteen representative locations across the delta, including locations in the Nigliq Channel, at the bridge crossings and at the Alpine pad facilities for the 10-, 50-

and 200-year floods. For three of the bridge crossings, predicted conditions for the mid-channel and abutment positions are presented. The thirteen locations are shown on Figure 4A.2.2-1. Table 4A.2.2-6 is derived from the data in Table 4A.2.2-5 and provides the predicted absolute change and the percent increase or decrease of water surface elevations and velocities at the same thirteen locations. For example, Table 4A.2.2-5 indicates that the 200-year flood depth-averaged velocity at the mid-channel Nigliq bridge crossing (i.e., location #4) is predicted to increase from 6.6 fps during existing conditions to 9.1 fps during proposed conditions. Table 4A.2.2-6 indicates that this is an absolute increase of 2.6 fps or a 39.0 percent increase. In reviewing Table 4A.2.2-6, two conditions have to be met for the results to be significant. The absolute velocity and percentage increases both have to be relatively high. From the tables, then high velocities and percentage increase occur mainly at the bridge sites.

A select number of figures from the Michael Baker (2002b and 2004a) reports are reproduced here to facilitate presentation of the model results. Figures 4A.2.2-2 through 4A.2.2-18 depict water surface elevation and velocity differences at various locations across the Delta, including at critical facilities, and for the Nigliq Bridge location for the 50- and 200-year floods. Figures 4A.2.2-2 through 4A.2.2-7 illustrate predicted water surface elevations and velocities during a 50-year flood and a 200-year flood under existing conditions (i.e., with CD-1 and CD-2 and associated facilities). Figures 4A.2.2-8 through 4A.2.2-18 illustrate predicted water surface elevations and velocities during a 50-year flood and a 200-year flood under the proposed 1,200-foot Nigliq Bridge scenario (Alternative A).

TABLE 4A.2.2-5 RESULTS OF TWO-DIMENSIONAL MODELING: WATER SURFACE ELEVATION AND VELOCITY MAGNITUDE COMPARISONS BETWEEN THE EXISTING CONDITIONS AND ALTERNATIVE A

ID #	Reference Location	2002 Baseline (CD-1 & CD-2 Only)						Alternative A Facilities and Structures					
		Water Surface Elevations (ft)			Velocity (fps)			Water Surface Elevations (ft)			Velocity (fps)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
1	Nigliq Channel North (approx. 5,600 ft. downstream of bridge)	6.8	9.7	11.5	5.5	6.6	8.6	6.8	9.6	11.3	5.7	7.3	8.7
2	Facility Northwest (approx. 4,700 feet east of Pt 1)	8.1	9.8	11.5	0.0	0.3	0.6	8.2	9.8	11.4	0.0	0.1	0.3
3	National Petroleum Reserve-Alaska Road 80 foot bridge												
	West Abutment (at centerline road)	-	-		-	-		-	11.1	12.4	-	4.3	5.2
	Channel (bridge mid-span)	-	-		-	-		-	11.0	12.4	-	4.0	5.3
	East Abutment (at centerline road)	-	-		-	-		-	10.9	12.5	-	3.3	4.8
4	Nigliq Bridge												
	West Abutment (location same for all models)	-	10.7	12.9	-	4.1	4.7	7.6	10.1	11.1	1.4	2.4	2.9
	Channel West (always 300 feet from west abutment)	7.4	10.7	12.8	6.3	6.1	6.8	7.7	10.6	12.4	5.3	7.1	9.2
	Mid Channel (always 600 feet from west abutment)	7.4	10.7	12.8	4.8	5.2	6.6	7.7	10.6	12.4	5.5	7.0	9.1
	Channel East (always 900 feet from west abutment)	7.4	10.6	12.7	4.1	4.9	5.8	7.6	10.5	12.3	4.8	7.0	9.1
	East Abutment (location same for 1,200-foot bridge and baseline models, varies for others)	7.4	10.6	12.7	4.0	4.6	5.2	7.1	9.2	10.2	1.5	2.2	2.9
5	CD-2 (southwest corner)	8.9	11.6	13.6	0.2	1.7	2.6	9.2	11.8	14.1	0.0	1.2	1.6
6	CD-2 Road 62 foot bridge (bridge mid-span approx. 40 feet upstream)	8.2	10.3	12.0	1.1	3.1	4.2	8.6	10.7	12.4	1.7	3.9	5.5
7	CD-2 Road 452 Foot Bridge												
	West Abutment (at road centerline)	8.0	9.5	10.9	1.3	3.2	4.4	8.1	9.6	10.8	1.4	3.2	4.4
	Channel (bridge mid-span at road centerline)	8.3	10.9	13.0	3.8	7.2	8.7	8.5	10.9	13.0	4.1	7.1	8.8
	East Abutment (at road centerline)	8.2	10.0	11.3	1.7	3.8	4.8	8.4	10.0	11.3	1.9	3.8	4.9
8	Alpine Pad South (southernmost pad corner)	-	12.0	14.3	-	0.5	0.8	-	12.9	15.4	-	0.8	1.4
9	Alpine Pad East (northeasternmost pad corner)	-	-	13.3	-	-	1.0	-	-	14.1	-	-	1.6

TABLE 4A.2.2-5 RESULTS OF TWO-DIMENSIONAL MODELING: WATER SURFACE ELEVATION AND VELOCITY MAGNITUDE COMPARISONS BETWEEN THE EXISTING CONDITIONS AND ALTERNATIVE A (CONT'D)

ID #	**Reference Location**	**2002 Baseline (CD-1 & CD-2 Only)**						**Alternative A Facilities and Structures**					
		Water Surface Elevations (ft)			**Velocity Magnitude (fps)**			**Water Surface Elevations (ft)**			**Velocity Magnitude (fps)**		
		10-Year	**50-Year**	**200-Year**	**10-Year**	**50-Year**	**200-Year**	**10-Year**	**50-Year**	**200-Year**	**10-Year**	**50-Year**	**200-Year**
10	Nigliq Channel South (approx. 6,200 feet upstream of bridge)	8.4	11.6	14.0	3.8	3.9	4.4	8.7	11.9	14.3	3.5	3.4	3.4
11	Facility Southwest (approx. 3,400 ft east of Pt 10)	9.0	12.1	14.3	0.2	1.0	1.5	9.2	12.2	14.5	0.2	1.2	1.8
12	Facility South (approx. 4,400 feet south of CD-2–CD-4 Road Junction)	-	12.2	14.6	-	0.2	0.6	-	13.2	15.8	-	0.2	0.4
13	CD-4 Pad (southwest corner)	-	13.8	16.1	-	1.3	1.6	-	13.9	16.1	-	0.6	0.9

Notes:
A dash (-) denotes the model predicts the location to be dry during that particular scenario.

TABLE 4A.2.2-6 RESULTS OF TWO-DIMENSIONAL MODELING: COMPARISON OF PREDICTED ABSOLUTE CHANGE AND PERCENT INCREASE OR DECREASE OF WATER SURFACE ELEVATIONS AND VELOCITY MAGNITUDES

ID #	Reference Location	Change: 1,200-foot bridge – existing conditions						Percent Baseline Conditions					
		Water Surface Elevations (ft)			Velocity (fps)			Water Surface Elevations (ft)			Velocity (fps)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
1	Nigliq Channel North (approx. 5,600 feet downstream of bridge)	0.0	-0.1	-0.2	0.2	0.7	0.0	0.4%	-0.6%	-1.6%	4.2%	11.1%	0.3%
2	Facility Northwest (approx. 4,700 feet east of Pt 1)	0.1	0.0	-0.1	0.0	-0.3	-0.3	1.5%	0.1%	-1.0%	0.0%	-76.5%	-50.8%
3	National Petroleum Reserve-Alaska Road 80-foot bridge												
	West Abutment (at centerline road)	-	-	-	-	-	-	-	-	-	-	-	-
	Channel (bridge mid-span)	-	-	-	-	-	-	-	-	-	-	-	-
	East Abutment (at centerline road)	-	-	-	-	-	-	-	-	-	-	-	-
4	Nigliq Bridge												
	West Abutment (location same for all models)	-	-0.6	-1.7	-	-1.7	-1.7	-	-5.6%	-13.3%	-	-40.9%	-37.3%
	Channel West (always 300 feet from west abutment)	0.3	-0.1	-0.4	-1.0	1.0	2.4	4.2%	-0.7%	-3.4%	-15.7%	17.2%	35.4%
	Mid-Channel (always 600 feet from west abutment)	0.3	-0.1	-0.4	0.7	1.8	2.6	4.1%	-0.8%	-3.1%	15.5%	34.4%	39.0%
	Channel East (always 900 feet from west abutment)	0.3	-0.1	-0.5	0.8	2.1	3.3	3.9%	-1.2%	-3.6%	18.7%	41.7%	56.7%
	East Abutment (location same for 1,200-foot bridge and baseline models, varies for others)	-0.3	-1.4	-2.5	-2.4	-2.4	-2.3	-3.7%	-13.4%	-19.9%	-61.3%	-52.6%	-44.7%
5	CD-2 Pad (southwest corner of pad)	0.3	0.2	0.5	-0.1	-0.5	-1.0	3.4%	1.9%	3.6%	-82.4%	29.9%	-38.9%
6	CD-2 Road 62-foot bridge (mid-span approximately 40 feet upstream)	0.4	0.5	0.4	0.6	0.9	1.3	5.0%	4.8%	3.3%	55.1%	28.4%	31.3%

TABLE 4A.2.2-6 RESULTS OF TWO-DIMENSIONAL MODELING: COMPARISON OF PREDICTED ABSOLUTE CHANGE AND % INCREASE OR DECREASE OF WATER SURFACE ELEVATIONS AND VELOCITY MAGNITUDES (CONT'D)

ID #	Reference Location	Change: 1,200-foot bridge – existing conditions						% Baseline Conditions					
		Water Surface Elevations (flood interval)			Velocity (fps) (flood interval)			Water Surface Elevations (flood interval)			Velocity (fps) (flood interval)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
7	CD-2 Road 452-foot bridge												
	West Abutment (at road centerline)	0.1	0.1	-0.1	0.1	0.0	0.1	1.5%	0.7%	-0.6%	11.2%	-0.6%	1.8%
	Channel (bridge mid-span at road centerline)	0.2	0.1	0.0	0.3	-0.1	0.1	2.3%	0.6%	-0.1%	8.8%	-1.5%	0.9%
	East Abutment (at road centerline)	0.2	0.1	0.0	0.2	0.0	0.1	1.9%	0.6%	0.4%	11.9%	-0.8%	1.2%
8	Alpine Pad South (southern corner of pad)	-	1.0	1.1	-	0.3	0.6	-	8.0%	7.5%	-	68.0%	74.4%
9	Alpine Pad East (northeastern corner of pad)	-	-	0.9	-	-	0.6	-	-	6.4%	-	-	57.8%
10	Nigliq Channel South (approximately 6,200 feet upstream of bridge)	0.3	0.2	0.3	-0.3	-0.4	-1.0	4.1%	2.1%	2.3%	-8.2%	-11.1%	-22.6%
11	Facility Southwest (approximately 3,400 feet east of Pt 10)	0.3	0.1	0.2	0.0	0.2	0.4	2.9%	1.0%	1.0%	5.6%	24.0%	24.8%
12	Facility South (approximately 4,400 feet south of CD-2/ CD-4 Road Junction)	-	1.0	1.2	-	0.0	-0.2	-	8.0%	8.2%	-	20.0%	-35.0%
13	CD-4 Pad (southwest corner of pad)	-	0.1	0.1	-	-0.6	-0.8	-	0.5%	0.4p%	-	-48.8p%	-46.9%

Notes: A dash (-) denotes that the calculation could not be made from the available data.

For all the figures representing both existing and Alternative A conditions, two views of the water surface elevation model (Delta and project) are presented, and three views of the velocity model (Delta, project and bridge-specific areas) are presented. The Delta scale is represented in Figures 4A.2.2-2 and 4A.2.2-3 for the existing conditions, and in Figures 4A.2.2-8 and 4A.2.2-9 for Alternative A. The project scale is represented in Figures 4A.2.2-4 through 4A.2.2-6, and 4A.2.2-10 through 4A.2.2-15. The bridge-specific scale is shown for only the velocity model of Alternative A in Figures 4A.2.2-16 through 4A.2.2-18. Based on the 2002 (Michael Baker, 2002b) and 2004 (Michael Baker, 2004a) modeling programs, and as depicted in the above-referenced tables and figures, the following generalized conclusions are made:

- As the Nigliq Channel bridge length increased from 900-ft to 1,500-ft water surface elevations increased slightly downstream of the bridge and CD-2 Road, and increased slightly upstream of the bridge and road. All the predicted changes, however, were less than a foot, ranging from about 0.1 to 0.8 ft (likely within or close to the margin of error). At all the bridges (i.e., 80-ft Paleochannel bridge, Nigliq Channel bridge, and the two existing bridges of 62-ft and 452-ft), however, the results were not as clear. Water surface elevations decreased or increased, depending on the bridge crossing considered when the Nigliq Channel bridge length increased from 900 to 1,200 to 1,500 ft. In particular, large + and - changes were evident for the bridge abutment locations (i.e., up to 1.6 ft for the east abutment on the Nigliq Channel bridge)
- For all cases, however, the differences between model runs with varying bridge lengths were even less after calculating scour. This is due to the presence of a scour hole which allows more water to be conveyed thereby reducing velocities and allowing higher water surface elevations.
- Significant velocity increases during frequent and infrequent floods would be generally confined to the channels; markedly increased overland flow velocities would not be expected as a result of the project during the infrequent floods. Smaller velocity increases as compared to baseline are expected during frequent flood events. Larger velocity increases are expected during infrequent flood events.
- In comparing predicted velocities for increasing bridge length, the model result suggests that as bridge length increased from 900-ft to 1,500-ft, depth–averaged velocities under the bridges (i.e., considering all four bridges) decreased over a range from 11 percent at some locations up to 79 percent at other locations. Decreases in velocity associated with increased bridge length were more pronounced at the Nigliq and paleochannel bridges than at the CD-2 access road bridges. At the same time, depth-averaged velocities downstream and upstream of the bridges, regardless of being in the channel or not, changed only marginally or not at all.
- As bridge length at the Nigliq crossing increased, discharge at the Nigliq crossing would be expected to increase, while discharge at the CD-2 access road bridges would be expected to decrease. Conversely, as bridge length at the Nigliq Crossing decreased, discharge there decreased and discharge at the CD-2 access road bridges increased.

In the event that floods on the Delta exceed design criteria (i.e., for the 50- and 200-year events), natural topography and man-made facilities would slow the flood flows and result in widespread inundation and sedimentation across much of the Delta. Flow constrictions would still occur at the main channel crossings and increase the potential for localized scouring of crossing structures and erosion of bridge abutment foundations and road embankments.

If design criteria are exceeded, the extent of additional bank erosion, channel scouring, and sedimentation that could occur would still be controlled by Delta topography. It is possible that a few locations would not be inundated during an event larger than the 1,000,000 cfs flow. However, flows will not necessarily be appreciably faster over most of the Delta, although erosion and sedimentation processes may be more prevalent.

One-Dimensional Modeling of the Ublutuoch River

The one-dimensional model HEC-RAS (hydrologic engineering center river analysis system) was used to predict water surface elevations and velocities for the Ublutuoch River from river mile 14.1 to 1.8 (Michael Baker, 2003, Michael Baker and Hydroconsult, 2004). Input data to the model included surveyed cross sections at seven different locations, Manning roughness coefficients determined from normal depth computations, discharge data at four separate locations, and interpreted hydrologic data at thirty-one locations (Michael Baker, 2003; URS, 2002). The design discharge numbers were derived using regression equations developed by URS (2002). The drainage area used in the regression equations was determined using USGS topographic map data and GIS software (M. Alexander, personal communication, July 2004).

Based on the 100-yr discharge estimate for river mile 8.0 (8,900 cfs) developed by URS and shown in Table 3.2.2-7, the HECRAS model delineated water surface elevations for the 100-yr floodplain from river mile 14.1 to 1.8 (Figure 3.2.2.1-9). For the 120-ft bridge option, the cross section was manipulated at mile 6.8 to reflect the geometry of the proposed bridge and determined to increase the water surface elevation from 12.6 to 13.5 ft BPMSL. This assumed that river ice was still in place. The width of the floodwater over the floodplain and channel at the crossing was estimated at approximately 1140 ft based on the known river geometry and a 12.6' WS elevation.

Scour Analyses

Scouring can affect the structural integrity of bridges and culverts and the channel geometry of areas upstream and downstream of bridges and culverts. Scour analyses have been conducted for the Nigliq Channel bridge site, and general scour concepts and mitigation measures have been analyzed elsewhere.

During February 2004, five borings were drilled in the Nigliq Channel and active floodplain along the proposed bridge crossing (Miller, 2004). The borings indicate that the channel sediments range from organic-silt, silt, silty sand and sand within the upper 35 feet. In deeper zones below 35 ft (to at least 80 ft), sections of gravelly sands and gravels are also found in addition to silts and silty sands. The sequences of sediments observed in all the borings collectively suggest recurrent east-west channel migration during aggradation, The upper 20 ft of the main channel (i.e., the thalweg is currently located nearer the west bank) is composed of sands. Further, the borings indicate that the sediments contain visible ice (from <5% to 30% depending on grain size) in the upper 30 ft of all the boring locations except the main channel boring. At depths greater than 30 ft visible ice is indicated in all the borings.

Site-specific models which assumed that the channel sediment is composed of non-frozen fine-grained silt were developed to evaluate the effect of the Nigliq Channel bridge on the velocity of water through the structure. Scour was estimated using the velocities predicted by the 2D model (assuming pre-scour channel elevations for the 1,200-ft bridge) and both Abscour and HEC-18 programs to determine the depth of scour (CPAI 2004). The results of the scour analyses were then integrated with the two-dimensional modeling results to determine post-scour water surface elevations and velocities The results suggested that the 50-year flow would result in a maximum scour of approximately 12 feet and the 200-year flow approximately 20 feet. These results are depicted in Figures 4A.2.2-19 and 4A.2.2-20.

Based on the results of the drilling, the two principal assumptions (i.e., the sediment across the entire channel and active floodplain is uniformly the same and comprised of uncompacted non-frozen silt) used in the scour calculations are not ideally met, Assuming the sediment is non-frozen silt, however, results in deeper scour estimates than if the sediment was either frozen or coarser, because uncompacted non-frozen silt is more readily scoured than frozen silt or non-frozen sands/gravels.

Because sediment grain sizes and ice conditions are not uniform across the main channel and floodplain, however, scour will likely not be uniform. It is possible that during the 50-yr and 200-yr events, the resultant hydraulic geometries will result in non-uniform scour, such that the non-frozen loose sands in the main channel may be preferentially scoured, while the partially frozen silts in the floodplain may resist scour. This may result in deeper scour in the main channel and less scour over the floodplain in order to maintain continuity and balance hydraulic geometries.

Based on the borings across the Nigliq Channel, the main channel and portions of the east floodplain are comprised of sands. These sands will be scoured during higher velocities under the bridge and then be deposited a short distance downstream due to attenuated velocities downstream of the bridge. The increased sedimentation on the floodplain and main channel could reduce low conveyance water capacity, which could affect navigability and fish passage during very low flows. The scour and sedimentation will occur episodically, resulting in episodic changes in channel characteristics downstream of bridge over the project lifepsan.

For each stream crossing only conceptual designs exist. Since scour-related impacts are possible without sufficient design components, it is conservatively assumed that some scour will occur. Although not likely, this could result in structural failure, additional erosion and downstream sedimentation, and impacts to aquatic habitat. In particular, the scour holes that are created at bridge crossings will result in increased sediment load. If the scoured material is predominantly fine-grained (i.e., silt), then much of the material will be transported farther downstream and to Harrison Bay. If the scoured material is predominantly coarse-grained, then most of the material will be deposited a short distance downstream of the bridge. This would result in reducing channel cross-sectional area and have impacts during low water period.

Bridge abutments and on-tundra aprons should be armored appropriately to protect the road and tundra from scour. During breakup when high flows are expected, the road (except for the outer skin) will be frozen and so scour potential is reduced. If required, culvert inlets and outlets would also be armored. Appropriate slope protection consisting of large gravel-filled fabric bags, armor rock, articulated concrete matting, revegetation, or other appropriate protection would be used where necessary. To protect all bridges (e.g., the Nigliq Channel, Ublutuoch River, and paleochannel bridges) from scour, the abutments would be armored and the piles would be set deep enough so that the structure would remain stable during the design scour event. Piling depths and bridge structural design will take into account the higher magnitude and less frequent floods; slope protection armor would protect against the more frequent, lower magnitude floods. This approach should provide less obtrusive armor to protect against the highest-risk events and to minimize initial habitat impacts caused by armoring. Armoring would be appropriate for bridges that cross completely over the channel and floodplain to avoid erosion and scouring processes. It is conservatively assumed that scour channel holes and bank scars with some structural failure (e.g., road and abutment washouts with downstream sedimentation) may occur, but that these impacts would be limited to the higher magnitude, less frequent events.

Scour at the piers and bridge abutments is a function of flow patterns approaching the structures and shape, alignment and size of the structures. Uncertainties in scour amounts, due to flow and water level uncertainty, are small compared to the potential variability in results due to flow pattern assumptions and techniques available for computing scour. These factors have been considered in the scour analysis for the Nigliq Channel bridge.

Scour estimates have been conducted for the bridge crossing, and the proposed bridge location and design will incoporate agency comments and analysis. In particular, the ADOT&PF is studying discharge and breakup processes on the Colville River in preparation for the proposal to construct a bridge as part of the State of Alaska’s proposed Colville River Road project (see Alternative C-2). ADOT&PF will be developing scour estimates associated with design flood values, and their analyses could be considered as a parallel to this project.

Limitations Associated With Hydrology Assessment Predictions

Concern over the accuracy and uncertainty associated with estimating high magnitude infrequent flood events with the limited available hydrology data for the Colville River has led to much discussion and analysis during the DEIS and FEIS review stages. The applicability and appropriateness of the current design criteria are based on:

- The accuracy of the historical peak flow estimates of the Colville River;
- The accuracy of the design flow estimates of the Colville River for various recurrence intervals;
- The assumptions of the upstream (i.e., assumed flows and proportion of these flows into the East and Nigliq channels) and downstream (i.e., water surface elevations at the mouth of the delta) boundary conditions;
- The model validity: how well the digital terrain model represents topography, how representative the finite-element node density is for the given topography, and how well specific model parameters (e.g., channel and terrain roughness) represent flow conditions on the delta; and

- How well designs and design-criteria have incorporated the effects of ice jams on water surface elevations, velocities and erosion processes.

Accuracy of Peak Flow Estimates

The accuracy of design flow estimates is based on the length of record and the accuracy of each data point within the record. There are 15 years of spring breakup peak flow estimates on the Colville River at Monument 1 (Table 4A.2.2-7) and only two years when continuous hydrographs were developed for river flow: the 1962 (Arnborg et al. 1966) station, and the 1977 USGS station, both at Monument 1 near Nuiqsut. The USGS installed an upstream gaging station on the Colville River at Umiat in August 2002.

None of these peak flows were measured by direct methods. Some of these annual peak flows (i.e., probably 1996-2003) were computed using a simplified USGS slope-area method (USGS Techniques of Water Resources Investigations, Book 3, 1967). The method could not be explicitly followed and was simplified because all the required input data were not available to calculate the energy-slope (i.e., high water slope measured on the west bank only, in some cases only one cross-section was available). Annual peak flow estimates computed by indirect methods can exceed 20 percent depending on: 1) how well the high water line (or surface slope) was identified and effected by ice, 2) the accuracy of channel roughness estimates, 3) channel widening in the downstream direction or flow expansion, and 4) the stability of the bed (or channel bottom). In some cases, however, errors can be over 40 percent due to the difficulty in determining high water lines during and after breakup. Computations made from cross-sectional, stage and slope data collected during ice-created backwater conditions (i.e., ice and/or snow in channel, downstream ice jams) may overestimate peak flows. Similarly, extrapolation of stage-discharge ratings during ice-effected flows will also overestimate flows. This suggests that at least some the peak flows listed in Table 4A.2.2-7 are overestimated. This bias was not carried forward in subsequent flood frequency analyses (Shannon & Wilson, 1997; Michael Baker and Hydroconsult 2002), which is discussed in the following section.

TABLE 4A.2.2-7 COLVILLE RIVER BREAKUP PEAK FLOW RECORD

Year	Colville River Peak Flow (cfs)	Measurement Method	Source
1962	215,000	Slope-area	Arnborg et al (1966)
1977	407,000	Stage-discharge extrapolation	U.S.G.S. (1978)
1989	775,000	Estimated from 2D model	Shannon & Wilson 1996
1992	188,000	Stage-discharge extrapolation	Jorgenson et al (1993)
1993	379,000	Stage-discharge extrapolation	Jorgenson et al (1994a)
1994	159,000	Stage-discharge extrapolation	Jorgenson et al (1994b)
1995	233,000	Stage-discharge extrapolation	ABR and Shannon & Wilson 1996
1996	160,000	Slope-area	Shannon & Wilson 1996
1997	177,000	Not provided	Michael Baker (2000)
1998	213,000	Slope-area	Michael Baker (1998)
1999	203,000	Slope-area	Michael Baker (1999)
2000	580,000	Not provided	Michael Baker (2000)
2001	300,000	Normal-depth	Michael Baker (2002)
2002	300,000	Slope-area	Michael Baker (2002)
2003	350,000	Normal-depth	Michael Baker (2003)

Accuracy of Design Flow Estimates

Shannon & Wilson (1997) and Michael Baker and Hydroconsult (2002) used regression analyses, paleo-evidence and an envelope curve (i.e., a hand-drawn curve tracing the upper bounds of the recorded annual peak flood values) to analyze and estimate design flows for Alpine area, and computed the 200-yr flood value to be approximately 1,000,000 cfs. While the error associated with the 200-yr estimate was not explicitly incorporated into designs, it has been assumed that the freeboard criteria accounts for this uncertainty. Due to the sensitive nature of these assumptions and the short-term record (i.e., the Michael Baker and Hydroconsult 2002 report used 14 years) of Colville peak flows, the uncertainty of predicting the flood flows for various recurrence intervals was further examined.

The Michael Baker and Hydroconsult 2002 report, entitled Colville River Flood Frequency Analysis Update, provides an estimated 50-yr peak discharge of approximately 730,000 cfs and an estimated 200-yr peak discharge of approximately 1,000,000 cfs. In the analysis, the 14-year Colville data set (i.e., without the 2003 peak flow) was extended using a regression analysis with the 30-year Kuparuk River data set. The analysis treated the 1989 Colville River observation of 775,000 cfs as an historic adjustment having an estimated return rate of 128 years, so it was not included in the analysis. The analyses concluded with the flood frequency design values in Table 4A.2.2-7.

TABLE 4A.2.2-8 FLOOD FREQUENCY DESIGN VALUES

Return Period	Flood Peak Discharge (cfs)	Upper 95percent Confidence Limit for Flood Peak (cfs)
2-year	240,000	280,000
5-year	370,000	460,000
10-year	470,000	610,000
25-year	610,000	770,000
50-year	730,000	1,030,000
100-year	860,000	1,260,000
200-year	1,000,000	1,550,000

The 95 percent confidence limits provided in Michael Baker and Hydroconsult (2002) indicate that the flood estimates for the infrequent events have an appreciably larger margin of error (i.e., approximately 50 percent for the 200-yr) than the more frequent events (i.e., approximately 24 percent for the 5-yr). This is expected with the short data record. As is indicated in the previous section, there is appreciable uncertainty in some of the peak flows used to calculate the flood frequency values. If the errors were random, then the upper 95 percent confidence limits are still valid; however, if the data is biased (primarily over or underestimated peak values), then the calculated upper 95 percent limit is not a true indicator of the variability in the estimate. Based on an analysis of reported peak flow stages and the discharges described above, there is a likelihood that the peak flows for 2000 and 2003 have been overestimated by 30 and 55 percent. Overestimates of peak flows may have introduced bias into the short-term record used to compute the estimates for the 200-yr, 50-yr and 10-yr flows, such that the re-computed design flows would be less after accounting for the overestimations.

With respect to the regression analyses summarized in the Michael Baker and Hydroconsult 2002 report, the resultant correlation between the Colville and Kuparuk data sets was only r = 0.5 (the correlation excluded the 1989 flow). This indicated that much of the variability in peak discharge in one river is not reflected (or modeled) by the other. Therefore, this variability contributes to the uncertainty in estimation of the Q_{200} peak discharge for the Colville River, and does not provide a compelling improvement to the analysis. The values in Table 4A.2.2-8 were not calculated using the Kuparuk regression analysis.

The Michael Baker and Hydroconsult 2002 report cite the investigations of the 1989 flood event, which are described in Geomorphology and Hydrology of the Colville River Delta, Alaska, 1996 by ABR, Inc. and Geophysical Institute of the University of Alaska, 1997. This work suggested a wide range of return intervals for the 1989 event. Depending on the geomorphic method and level of conservatism assumed, the estimated return periods for the 775,000 cfs ranged from 67 to 393 years. The 1997 report conservatively settled on “the order of a 100-year event” for the 1989 event, but suggested that without the conservative biases it could be as much as a 150 to 300 year event. The September 2002 Report appears to have used only one of the values - 128 years (± 32 yrs) - from the 1997 report, which was the mean return period for what they apparently considered to be the most reasonable method in the 1997 report.

The 1989 peak flow event is not well documented and is estimated from the identification of 26 high-water lines, of which only 17 of the sites could the absolute elevation be established to ± 1.0 ft. The flood was observed in only a few locations, rafted ice was observed strewn on floodplains afterwards, but no direct or indirect discharge measurements were collected. Based on these analyses, they estimated that the 1989 flood had a peak discharge of 775,000 cfs; the estimate had a flow range of 665,000 to 930,000 cfs based on one standard deviation (±0.9 ft) of the accuracy of measuring water surface elevations from high water lines. Because of the high uncertainty associated with the estimation of the 1989 peak flow, the calculated flow value of 775,000 cfs should not be relied on for use in flood frequency calculations and regressions.

A comparison of the flow record with the flood frequency design values indicates that the 50-year design value of 730,000 cfs has been exceeded once (i.e., if one considers the 775,000 cfs in 1989) and the 10-year design value of 470,000 cfs has been exceeded twice in the 15-year record. Conservatively, using the predicted flows for the upper 95 percent confidence limit, the 25-year value of 770,000 cfs was exceeded once by the 1989 event.

When considering all the analyses and their inherent uncertainties, it is not clear that the estimated 200-yr flow of 1,000,000 cfs is conservative enough. Considering standard errors from the Michael Baker and Hydroconsult 2002 report in a conservative fashion could result in a 200-yr design value that is substantially more than 1,000,000 cfs (as much as 50 percent). Therefore, to account for this uncertainty, the 2D model was run at a higher flow of 1,300,000 cfs, to assess the possible effects of underestimating the 50-yr and 200-yr flood values. These results are presented as rating curves at specific locations for each facility or point of interest along the proposed and existing roads, and are discussed later in this section.

In general, calculated 200-year unit runoffs for sites in the region range from 30 cubic feet per second per square mile (cfsm) for the north Brooks Range streams, to over 70 cfsm on the Seward Peninsula. A few on the coastal plain in the vicinity of the project area (e.g., Kuparuk River) fall in the 50 cfsm (Curran et al. 2003). Also, in general, it has been well established that as basin size increases unit runoff tends to decrease for a given region (Dunne and Leopold, 1977). The issue here is whether there are sufficient data in the National Petroleum Reserve-Alaska region to define reasonable unit runoff ratios for large magnitude infrequent events. The calculated unit runoff for the Colville assuming the proposed 200-yr of 1,000,000 cfs is 48.4 cfs per square mile (cfsm), similar to the other values in the coastal plain area largely because the value was calculated using principally the Kuparuk data record. For comparison, at discharges of 770,000 and 1,300,000 cfs the unit runoffs would be 37.3 and 62.9 cfsm, respectively, and both within the observed range for the northern Brooks Range, so it is reasonable to use the 1,300,000 cfs scenario as an upper bounds on addressing freeboard and other design criteria.

The result of underestimating flows for the design criteria can have substantial downstream impacts that include underestimating water surface elevations, levels of inundation and backwater, underestimating conveyance capabilities of various bridge and culvert structures, misrepresenting the velocity distribution during high flows on the delta, and underestimating the prevalence of erosion and sedimentation zones. The result of overestimating flows reduces environmental risks but increases engineering and construction costs.

Assumptions of Boundary Conditions

Up to this point, the discussion has centered on understanding the volume of flows coming down the Colville River upstream of the split between the East Channel and the Nigliq Channel. Because the location of existing and proposed Alpine facilities lies within the western portion of the Delta with flow controlled by the Nigliq Channel system, it is very important to understand what governs the proportion of flow into the Nigliq Channel, and how this flow proportion changes over time based on stage and channel geometry.

The channel and floodplain geometry at the entrance to the Nigliq Channel has changed over time due to upstream and downstream erosion and sedimentation processes. This has also caused the proportion of flow carried by the Nigliq Channel to change.

Based on a review of historical USGS topographic maps, historical air photos and reports by Walker (1983, 1994) and Shannon & Wilson (1996), the following is evident:

- The 1955 version of the USGS Harrison Bay (A-2) 1:63,360 map shows the main entrance to the Nigliq Channel as the Putu Channel; the entrance is at a right angle with the East Channel, while a highwater channel entrance to the Nigliq is located 4 miles upstream from the Nigliq-Putu (and just downstream from the Monument 1 location);

- The 1995 panchromatic image (Shannon & Wilson, 1996) shows that the 1955 highwater channel is now used as the main entrance to the Nigliq, but that its entrance had migrated northward 3,500 ft; the 1995 image also shows that Putu connection with the East Channel had migrated about 3,000 ft northward and joins at a steep angle (i.e., not at a right angle);

- On images, photos and maps, it is also evident that channel width expands northward at the head of the Delta and the entrance to the Nigliq Channel, so that this area is an area of deposition, which may explain why the entrance to the Nigliq Channel is constantly changing and adjusting to episodic sediment flux.

Walker (1994) identified what he termed "the rapidity of sedimentation within parts of the delta and especially those parts that impact the residents of Nuiqsut." He found that residents of Nuiqsut were facing major problems related to boat transportation. He assessed three areas of the upper Nigliq Channel where naturally occurring sedimentation had resulted in decreased depth and thus navigability: the Putu Channel, the headwaters area of the Nigliq, and the dredge channel near Nuiqsut.

The Putu Channel is a narrow connection between the East and Nigliq Channels that is subject to rapid, naturally occurring sedimentation. According to Walker's findings, the Putu was easily traversable in the 1960s, even during the low water summer period. During the 1970s, the channel became less passable, and by the early 1990s, became impossible to navigate at low stage. Further, he found that the rapid sedimentation at its mouth forced the east entrance of the Putu to migrate northward. Between 1949 and 1992, Walker estimated that the east entrance had gradually been pinched and forced north a distance of about 1 mile by naturally occurring sedimentation.

Walker also concluded that between 1949 and 1992, the Nigliq Channel entrance migrated northward about 0.7 miles due to sedimentation. This shift has had a major impact on the navigability, led to dredging operations in the channel adjacent to Nuiqsut beginning in 1982, and continues to be one of deposition. He stated that this is a natural process that will continue into the future. In the Michael Baker summary report (2004c), they concluded that natural sedimentation processes have rendered the Putu Channel unusable with respect to navigation for all but a fraction of the open water months. The entrance of the Nigliq, because of its location of divergence of the Colville River, is an area of reduced velocity and naturally occurring deposition (i.e., bankfull channel widens, slope flattens, and deposition results). They suggested that continued growth of the sand bar at the entrance of the Nigliq would result in further slowing of velocity and increased sedimentation. Whether this process is manifest during high magnitude infrequent flood events is possible, but not definite. Based on flood conditions (i.e., locations of ice jams during breakup), the extreme flows may just as readily scour out the entrance and open up the channel and cause deposition in another location.

In essence, the uncertainty here rises from first not having discharge data for the Nigliq Channel entrance or at the bridge site, and secondly from knowing that the natural processes are very dynamic. The ability to predict how the delta will evolve over the next 20 to 50 years is hampered by our lack of delta-wide observations, a good long-term aerial photographic record, a comprehensive understanding of spring break-up dynamics, and an understanding how changes in the volume and distribution of the Arctic Ocean ice cap (as influenced by global climate changes) are affecting rainfall-runoff, fall snowmelt and winter snowfall, and macro (Colville River Basin) and meso-scale (i.e., Colville River Delta) climate and permafrost conditions .

In the 2D open-water model, the proportion of flow entering the Nigliq Channel is determined by channel geometry, delta topography, water surface slope and channel/floodplain roughness. Based on model output, the predicted proportions of Nigliq Channel flow during the 10-yr, 50-yr and 200-yr events shown in Table 4A.2.2-9 are 19.6, 22.3 and 24.6, percent respectively (Michael Baker, 2004h), indicating that the model predicts that as flow increases the Nigliq Channel should carry a higher proportion of the total Colville River flow at Monument 1. According to Michael Baker (2003), during the 2003 peak break-up discharge of 350,000 cfs the Nigliq Channel carried about 61,000 cfs or 17 percent of the total measured flow. (As mentioned above, the 2003 peak flow of 350,000 may be overestimated, so the flow proportion may be underestimated) In 1995, the Nigliq Channel carried an estimated 38 percent of the 233,000 cfs Colville River peak discharge (ABR and Shannon & Wilson 1996). Further, on July 20, 2004, with very low flows measured at Monument 1 (17,100 cfs), the Nigliq Channel entrance was measured to carry only 3.8 percent (650 cfs) of the total flow (R. Kemnitz, 2004). Based on these values, it is clear that the proportion of these flood flows entering the Nigliq Channel is dynamic. Further, all of the above scenarios consider open water conditions only.

TABLE 4A.2.2-9 PROPORTIONS OF NIGLIQ CHANNEL FLOW TO MONUMENT 1 FLOW

	Monument 1 Flow	East Channel below Nigliq	Nigliq Entrance	Nigliq near CD-4	Nigliq at Bridge Crossing	Measurement Method
July 20, 2004 (a)	17,100		650 (3.8%)			Direct streamflow
2003 peak (b)	350,000				61,000 (17.0%)	Indirect Slope-area
1995 peak (c)	233,000	144,000 (61.8%)	89,000 (38.2%)		37,000 (15.9%)	Direct streamflow
Q10 (d)	470,000			92,100 (19.3%)	85,900 (18.3%)	Predicted by 2D model
Q50 (d)	730,000			162,800 (22.3%)	142,000 (19.5%)	Predicted by 2D model
Q200 (d)	1,000,000			246,000 (24.6%)	213,000 (21.3%)	Predicted by 2D model

Sources: a) Kemnitz, 2004, b) Michael Baker, 2003, c) Shannon & Wilson, 1996, d) Michael Baker, 2004h

Due to ice jams, breakup flows could cause the Nigliq Channel to carry a much larger proportion (i.e., possibly over 50 percent) and very low flows could carry less than one percent simply because the change in channel capacity with elevation is not linear (i.e., more capacity becomes available in subordinate channels at slightly higher elevations).

The current design for the 1,200-ft bridge is based on a 200-yr maximum flow of approximately 213,000 cfs. The concern is then, for example, what is the likelihood that flows and under what conditions could flows be greater than 213,000 cfs at the bridge crossing (i.e., are the designs sufficiently conservative). The result of underestimating Nigliq Channel discharge during high flows can have substantial downstream effects including increased scour, erosion and sedimentation, and bridge, pipeline and road failures. Thus, three conditions associated with the Nigliq Channel flow proportion must be considered in addressing uncertainty and assigning freeboard: ice-jam effects, short and long-term evolution of channel and floodplain geometry, and model inaccuracy.

Accuracy of Model

The 2D Delta model was calibrated at a flow of 110,000 cfs (i.e., matched observed with predicted water surface elevations) and validated at the higher water surface elevations estimated for the 1989 flood.

The differences between measured and modeled water surface elevations at a modeled flow of 110,000 cfs were fairly good and ranged from -0.5 to +0.4 feet, while differences in measured and modeled discharges at five locations across the delta ranged from –7.3 to +6.4 percent (Michael Baker, 2004a). Some of the error can be attributed to the density of node-spacing and the effect of depth-averaging over broad distances (over 500 ft across much of the delta but with breaks at major topographic changes and at facilities, and much finer around the bridge sites). Because the model is delta-wide (i.e., over 10-miles wide at the Alpine facilities and over 25 miles long between upstream and downstream boundaries), it has limited uses for site-specific areas (i.e., the shortest node spacing is 80 ft under the bridge). This also means that specific model parameters (i.e., channel and terrain roughness) are also represented by average values for each node.

For model validation using the 1989 flood, Shannon & Wilson (1997) used drift-line elevations identified by ABR (1997) in conjunction with the 2D model to estimate the magnitude of the discharge that best fit the drift line elevations. Based on these analyses, they estimated that the 1989 flood had a peak discharge of 775,000 cfs; the estimate had a flow range of 665,000 to 930,000 cfs based on one standard deviation (±0.9 ft) of the accuracy of measuring water surface elevations from high water lines. Thus, the higher flow conditions as predicted by the model do not have the same level of accuracy as the low flow values, but Shannon & Wilson (1997) concluded that the results were reasonable given the available database. They further indicated that the high flow estimates could be improved by calibrating the model with measured high flow values, but that due to logistics and the physical constraints related to measuring high flows during breakup, this may not be easily achievable and therefore not depended on.

Based on the error observed at 110,000 cfs, CPAI hydrologists estimated that computed water levels for higher flows will likely have an error of less than 1 foot (i.e., relative elevation at a particular node location and not absolute elevation) (Michael Baker, 2004a). This is supported by the nature of delta topography, in that water surface elevations will increase faster in the channel with increasing flows than outside the channel. Thus, once a flood reaches the floodplain large increases in discharge can be accommodated with very little water surface elevation change.

This assumption is probably valid for average depths over most of the delta where topographic variations are well represented by the digital terrain model used in Finite Element Surface Water Modeling System (FESWMS), but may not be appropriate for specific locations due to variations in channel and delta topography. Further, channel geometry is not constant over time, especially when considering erosion and sedimentation processes. It is unclear, how representative the existing digital terrain model is because it is based on air photos taken in the 1990s and ground surveys collected over the past several years, but it is probable that most of the model represents the average topography fairly well.

As discussed above, to account for this variability and determine the degree of uncertainty in water surface elevations at the high flow values, the model was also run for a higher flow of 1,300,000 cfs. Rating curves showing the predicted water surface elevations at specific flows for various proposed and existing Alpine facility locations around the delta are presented in Figures 4A.2.2-21 to 4A.2.2-38. The rating curves are plotted in comparison to the design water surface elevations for each location. For example, Figure 4A.2.2-22 is a stage-discharge rating curve for the road between CD-2 and CD-5 at the paleochannel swale bridge west of the Nigliq Channel. The plot depicts the predicted water surface elevations for six scenarios and compares the results to ground surface and the elevation of the design bridge deck. The plot indicates that for the proposed action (i.e., CD 1,2,3,4 & 1,200 ft bridge on figure), water surface elevation increases from about 11.1 ft to 13.0 ft to 13.8 ft for flows of 730,000 cfs, 1,000,000 cfs and 1,300,000 cfs compared to a bridge deck elevation of 20.0 ft. The plot also indicates that the design criteria of the 200-yr water surface elevation + 1.0 ft will be adequate.

The results of the delta-wide model should be used cautiously to depict conditions down to the scale of it’s node-spacing and should not be used to establish flow conditions for designs in specific areas (that are equal to or less than the node-spacing). In these instances (e.g., cross-drainage culverts along CD-4 Road) local hydraulics, erosion, and sedimentation processes must be taken into account as well.

Ice Effects

Current elevation design criteria for facilities (i.e., pads, roads, bridges, etc.) related to the physical environment have not been explicitly developed to consider the effects of ice jams and related ice effects on water surface elevations, but are based on either the prevention of thermal degradation of permafrost (i.e., requiring a minimum pad or road thickness) or on minimizing the risk from open-water flooding (i.e., when ice is not present).

Because of the uncertainties associated with analyses in support of designs (including ice effects), freeboard is incorporated into all the criteria. The issue here is whether the design water surface elevations and freeboard are conservative enough to account for the unknowns associated with predicting the locations, frequency, magnitude and duration of ice jams and flooding associated with ice jams.

Flooding and diversion of flow due to the presence of ice jams in the active channel occurs annually in the Colville River Delta. The magnitude of the flooding and diversion differs markedly, ranging from minor areas of localized backwater to flow over broader areas of the floodplain, and as such, some degree of backwater is associated with any ice jam (Michael Baker, 2004d).

Several large-scale examples of ice-induced flooding have been observed on the Delta. As described in Section 3.2.2.1, in 1981 a large jam at the mouth of the Nigliq diverted a larger than normal volume of water back into the East Channel. A 1974 flood described by Nuiqsut villagers and having flooding characteristics of ice jams (i.e., apparently local flooding only) brought water levels to very high levels near the village, and in 2004 the ice jam at the East Channel entrance shunted a disproportional amount of water down the Nigliq Channel. While these incidents and other incidents have been reported on the Delta, ice-jam related floods are not well documented and are less understood than open-water floods.

Based on the observations of breakup in the Delta and in conjunction with earlier reports, Michael Baker (2004d) concluded that the effectiveness of an ice jam in creating backwater conditions in the Delta is regulated at some point by the relatively flat terrain in the Delta. That is, backwater and floodplain inundation from an ice jam will increase the water surface elevation to a threshold defined by channel geometry and topography. This conclusion concurs with Michel's (1971) theoretical derivation of the stability of a jam. Michel describes a physical limit to the thickening of an ice cover under the effect of hydraulic forces. He states that if the discharge is slowly raised under an ice accumulation the cover thickens by shoves until the increase in hydraulic thrust, due to the reduction of flow area, becomes higher than the resistance of the cover to this thrust.

Michel (1971) mathematically demonstrates that the maximum discharge before shove is directly proportional to the river depth and channel width and inversely proportional to ice and channel roughness. This means that as the discharge reaches a critical water level where either the depth and or width exceed resistance conditions (i.e., overbank discharges), the ice jam tends to release. However, Michel also indicates that if the plug or jam is itself sufficiently resistant, water will rise upstream and find an alternate route and bypass the jam. In many cases with dry jams, most of the discharge can be deflected, possibly even leading to the formation of a new channel or the occupation of abandoned or less used channels. These conditions, although apparently not frequent on the Delta based on past observations, could occur if breakup was rapid, river water levels increased rapidly, and ice strength was still high.

Michael Baker (2004d) performed a computerized simulation of ice jamming in the Colville River using models that were constructed and analyzed with the 2D-model FESWMS described above in sub-section Hydrologic Analyses and Modeling to Assess Effects of Roads, Pads and Bridges. The head of the East Channel was selected as a potential ice jam location for modeling. As noted in Table 3.2.2-9, ice jams have been observed to form here in three of the past seven years, and during breakup 2004 when the ice jam occurred there, a much larger proportion of Colville River flow was re-directed down the Nigliq Channel (Michael Baker, 2004d). It was also observed that the Alpine area experienced appreciably high water levels, much higher than what would have occurred in the absence of a jam. Thus, with an ice jam at this location, additional flow down the Nigliq Channel could potentially create a large impact on water levels in the Alpine area.

This location was considered by Michael Baker (2004d) to be the worst-case scenario because of the possibility of diverting a majority of Colville River flows down the Nigliq. Other such scenarios are also plausible, but it is difficult to make a quantitative judgment of impacts because of the complexity in analyzing or modeling the effects of ice jams. Other possible, but unlikely scenarios might include ice jams in several critical locations across the Delta resulting in a much more widespread backwater and flood release effect, or an ice jam at the Nigliq Channel bridge, which might shunt a disproportionate amount of water towards the swale bridge on the CD-2 road and threaten the existing facilities. Nevertheless, the modeling analysis provides a useful framework to address the potential effects of ice jams.

To simulate the ice jam at the East Channel entrance, elements that defined channel bottom characteristics were revised to represent a groundfast ice jam. The jam was modeled by raising the elevations 9 ft above of the normal elevation of the Colville River channel bottom (or approximately one-third the channel depth at the thalweg position during the 10-yr and 50-yr flows). The 9 ft thick ice jam is approximately 1.5 times the 6 ft ice thickness commonly observed as a relatively thick floe in the Delta. Based on the Michael Baker (2004d) report, the dimensions of the hypothetical ice jam appear to be approximately 2,000 ft wide (perpendicular to flow) by 900 ft long (in the direction of flow).

This hypothetical ice jam does not have some of the important attributes observed in previous ice jams. First, it is fairly small compared to the 5,000 ft by 1,250 ft size of jam observed at the East Channel entrance in June 2004, and does not extend across the entire 3,300 channel width. Second, the long-axis for the ice is perpendicular to flow, rather than diagonal. Thus, the hypothetical jam may not be big enough to represent worst-case type conditions and divert a larger portion of flow down the Nigliq Channel. Third, the 2004 ice jam was floating across the main channel and shorefast to the channel banks and bars, not bottomfast. The floating ice (simple jam) forces water under the floe to flow under hydraulic pressure, whereas the bottomfast jam is more similar to weir-type fluid dynamics. Both reduce flow, so the principal objective of the model is still likely met. Nevertheless, depending on the flow levels assumed, the simulation does provide a mechanism to evaluate ice-jam type dynamics (i.e., creating backwater conditions and redirecting flows). For example, the 9-ft modeled ice jam resulted in an increase in water surface elevations upstream of the jam by 0.71 ft and 0.50 ft for the 10-yr and 50-yr flows, respectively. Downstream of the ice jam, water surface elevations in the East Channel decreased by 0.13 ft and 0.05 ft, respectively, while water surface elevations downstream in the Nigliq Channel increased by 0.52 ft and 0.27 ft, respectively. Based on these results, Michael Baker (2004d) concluded that relative water surface elevation increases were greater for 10-yr floods than 50-yr floods, but by the time the effect of the rise reached the Alpine area, very little change was predicted and no adjustments to freeboard criteria were necessary at any of the proposed Alpine facilities.

Table 4A.2.2-10 compares the change in cross-sectional area, average velocity and discharge as a result of the hypothetical ice jam in the East Channel for both the 10-yr and 50-yr scenarios (data developed from Michael Baker, 2004d). Based on the model results, an ice jam with the 10-yr flood redirects only about 3% (or 11,400 cfs) of the East Channel flow into the Nigliq entrance, while the ice jam with the 50-yr flood redirects about 8% (or 43,100 cfs) to the Nigliq. In both cases, the total ice-effected Nigliq flow did not cause a significant proportion of the East Channel flow to be redirected. Further, the model results also depict that some of the redirected water is returned back to the East Channel via the Putu Channel. Thus, the model suggests that at high flows greater than or equal to the 10-yr flood, ice jams will not cause major shifts in the proportion of flows between channels. This finding does not necessarily agree with the observation of the East Channel ice jam and resultant flow re-distribution during the 2004 breakup. However, the 2004 breakup flows were apparently considerably smaller (on the order of a 2-4 yr flow [M. Alexander, personal communication, 2004]), so that re-direct effect may be greater at the lower flows.

TABLE 4A.2.2-10 COMPARISON OF SIMULATED PRE AND POST ICE-JAM FLOW PARAMETERS FOR EAST AND NIGLIQ CHANNEL

	Simulated 10-year Flood	Simulated 50-year Flood
Total Flow at Monument 1	470,000 cfs	730,000 cfs
East Channel With No Ice Jam		
Total Flow	378,000 cfs (80.4%)	567,000 cfs (77.7%)
Total Cross-Sectional Area	96,900 ft^2	113,400 ft^2
Average Channel Velocity	3.9 fps	5.0 fps
East Channel With Hypothetical 9-ft Bottomfast Ice Jam		
Total Flow	366,000 cfs (77.9%)	524,000 cfs (71.8%)
Total Cross-Sectional Area	59,100 ft^2	74,900 ft2 ft^2
Average Channel Velocity	6.2 fps	7.0 fps
Nigliq Channel Downstream of Putu With No Ice Jam		
Total Flow	92,000 cfs (19.6%)	163,000 cfs (22.3%)
Nigliq Channel Upstream of Putu With Ice Jam in East Channel*		
Total Flow	104,000 (22.1%)	206,000 cfs (28.2%)

Notes:

*Some of the Nigliq flow is returned to the East Channel via the Putu Channel, so the before and after ice-jam values cannot be directly compared. Assuming the Putu is still choked with bottomfast ice so there is little conveyance capacity, then the upstream values can be assumed to approximate the downstream values.

The modeling report (Michael Baker, 2004d) also examined the potential affect of water depth on ice jamming. From their analysis they concluded that based on modeled water depth patterns for the 10-yr, 50-yr and 200-yr flows, ice jams are more likely during 10-yr floods and are least likely during 200-yr floods. They also infer that ice jams are also more likely at even lower flows. Michael Baker 2004d indicated that in some locations, where water depths exceeded 25 ft, there would be adequate cross-sectional area to pass sufficient flow to minimize backwater effects during a jam. Further, they reasoned that for overbank flow, rafted ice is a primary cause of jamming, but that during the 50-yr and 200-yr floods, water depths are sufficient to avoid overbank floodplain ice jams.

The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and their hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a "worse-case" location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations will be exceeded by floodwater even when ice-jamming conditions are considered.

Although, these conclusions are reasonable and intuitive, the modeling does not support this conclusively because of the limitations described above. The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta. However, model results should be viewed cautiously due to the difficulty in accurately simulating ice jams, for example; the hypothetical condition does not appear to be representative of the 2004 condition. That is, the size, orientation, and condition (bottomfast versus shorefast and floating) of the modeled ice jam did not result in a significant large re-direction of flow, which was observed to occur in 2004.

Impacts to Pipelines, Roads, Culverts, Bridges, and Pads During Operation

Impacts Related to Pipelines

Natural drainage patterns can be disrupted if pipeline-crossing structures block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Conceptual designs and general criteria indicate that the proposed pipeline VSMs will not be located in any drainages (except at the very wide crossings where they will be co-located on bridges). In general, design features have been incorporated to protect the structural integrity of pipeline-crossing structures (from scour, ice jams, ice impacts, storm surges, and backwater effects from land-fast sea ice) to accommodate all but the rarest flood events. The alignment of the proposed pipeline would cross the Nigliq Channel, the Ublutuoch River, and other small drainages, and would follow a separate alignment 350 to 1,000 feet from the access road, except at the bridge crossings.

The proposed pipeline corridor to CD-3 follows naturally occurring higher ground, crossing 450- to 750-foot wide sections of the Ulamnigiaq, Tamayayak, and Sakoonang Channels (see Figure 3.2.2.1-3). The pipeline route to CD-4 follows the existing pipeline route parallel to the proposed CD-4 Road but to the east and across the paleochannel. The pipeline route to CD-5, CD-6, and CD-7 would have to cross eight drainages, including the 1,200 foot-wide bridge span on the Nigliq Channel. Pipeline bridges (box girder design) would be used only at major crossings, while large, broadly-spaced VSMs would be used for minor crossings. Therefore, impacts related to flow constriction would be unlikely at the minor crossings at all flows. The potential for ice jams at the pipeline crossings would be minimized by design criteria that will require that the VSMs allow for free passage of ice, and more conservatively account for any additional forces that could damage support structures.

In the event of an ice jam, the increased forces exerted on the VSMs and backwater processes will result in an increase in inundated terrain.

In general, on the Delta and with the major stream or river crossings, pipeline-crossing structures are designed with more stringent standards than road-crossing structures because of the greater sensitivity of the environment to a structural failure. Pipeline-crossing structures are designed to accommodate the 200-year return flood (plus 1 foot of freeboard). Pipeline failure can result in oil spills, as discussed in Section 4.

Impacts Related to Roads

Natural drainage patterns can be disrupted when roads block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. The potential impacts occur during the operations period, but are best avoided by design considerations prior to construction. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Causeways and bridges that do not convey water adequately can constrict flows and result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for flooding. These effects can be minimized by incorporating design features to protect the structural integrity of the crossing structures from scour, bank erosion, ice jams, ice impacts, and storm surges to accommodate all but the rarest (depending on design criteria) flood events.

Where roads cross floodplains, dunal complexes and ancient alluvial-marine terraces (i.e., the proposed road to CD-4 and the west extension of the road from CD-2) of the Colville River Delta, they are designed to accommodate the 50-year return flood (plus 3 feet of freeboard). Except for the stream crossings, project roads elsewhere in the Plan Area (the proposed road from CD-5 to CD-6 and CD-7) may not require the same flood design criteria because they would not be in a flow environment. Because most of the road from CD-2 to CD-5 crosses the Nigliq Channel and the paleochannel to the west it will consist of mainly of bridge and bridge approach aspects, so that the impacts from the road from CD-2 are addressed below in the subsection: Impacts Related to Bridges.

The proposed road from Alpine to CD-4 is hydraulically fundamentally different than the existing Alpine to CD-2 Road (Michael Baker, 2004h). The CD-2 Road runs east-west and crosses delta channels (i.e., perpendicular to flow). However, the CD-4 Road runs north-south (i.e., parallel to flow). About 80 percent of its alignment follows a naturally occurring topographic high (i.e., ancient dunal complex) that forms a natural barrier between two drainage sub-basins; to the east floodwater flows northward along a paleochannel-lake complex from the Sakoonang Channel sub-basin, while to the west floodwater originates as overflow from the Nigliq Channel and occupies Lake 9323 and Nanuk Lake. The remaining 20 percent of the proposed road (i.e., primarily the northern section near Alpine) would traverse relatively low ground and form only discontinuous separation of the Nigliq and Sakoonang sub-basins. This area is exposed to more frequent flooding, but because the road is still designed for 50-year return flood (plus 3 feet of freeboard), overtopping of the road with adequate cross-drainage will occur less often. Based on two-dimensional modeling and field observations (Michael Baker 2002b), flow across the proposed road alignment is infrequent, localized, and has little or no apparent impact on the ground conditions, vegetation, and hydrologic regime between the east and west sides of the alignment.

The two-dimensional hydrologic model of the delta addresses the effects of the CD-4 Road on the surface hydrology western portion of the Delta at various flood frequencies. The results suggest that the road to CD-4 will, during larger flood events (i.e., greater than the delta-wide 10-yr open-water flood, or a local ice-jam effected flood), divert some water from passing through the swale bridge and cause it to flow eastward around CD-1 and joining back up with the swale bridge flow on the north side of CD-1. Modeling results for the 200-yr event (and 1,200-ft bridge scenario) suggest that a difference in water surface elevation of 1.0 to 4.0 ft between the east and west sides of the CD-4 road and the existing Alpine pad will result (Figures 4A.2-4, 4A.2-5, 4A.2-10, and 4A.2-12). The CD-4 road within the delta will channelize the water to flow through both the main Nigliq Channel bridge and the 80-ft bridge on the west (Figures 4A.2-11 and 4A.2-13). Depending on the flood volumes, the routing of water on the west side of the Delta is restricted to the four bridge sites, so that water surface elevation would back-up behind the road and flow directions would be changed. Some of this effect could be reduced by installing adequately-designed overflow or cross-drainage features (culverts and/or culvert batteries) into the CD-4 road. The 2D model did not incorporate any cross-flow drainage features. However, hydraulic capacities of 48-inch and 60-inch culverts are not sufficient to affect the results of the delta-wide model. Thus, neglecting the hydraulic influences of culverts is a conservative position that overstates the predicted difference in water surface elevations.

The results of the 2D open-water modeling for various flood frequencies are compared to CD-4 road design criteria on site-specific rating curves (Figures 4A.2.2-31 to 4A.2.2-34). Four representative points along the road are depicted. The locations of these points are shown on Figure 4A.2.2-22. The results suggest that for large magnitude less frequent events the elevation of the proposed CD-4 Road at the four points is 2.8 to 6.7 ft above the 50-yr flood level. Design criteria states that the road will have to be built to the 50-yr level plus 3 ft for freeboard. Thus, some of this road (based on preliminary design elevations) may not be high enough.

Similarly, rating curves for the Alpine/CD-2/National Petroleum Reserve-Alaska Road are shown on Figures 4A.2.2-22 to 4A.2.2-30. The figures show that at the roads four points depicted in Figure 4A.2.2-21, predicted 50-yr water surface elevations are 5.2 to 8.2 ft below the proposed road elevations, so it appears that this road is high enough after accounting for 3 ft of freeboard. The CD-3 facilities are basically islands during a large flood event. They do not cut off any major channels of flow and the water will flow around them and recombine on the downstream side. Roads topped by floods can become unstable resulting in erosion of road fill and deposition in surrounding areas.

Impacts Related to Culverts

Detailed information about culvert placement and design has not been provided. As a result, the impact of culverts is addressed qualitatively and conservatively. Culverts and/or culvert batteries are required at all water crossings that do not need a bridge. At a discharge of 500 cfs, the number and spacing of culverts required to pass the flow and/or ice may not easily fit within the specific channel/floodplain it is being designed for. Therefore, a bridge would be considered when channelized flow occurs with a 50-year flood of 500 cfs or more. Culverts would be installed when the road is constructed. Additional culverts could be added if later observations indicate that ponding is occurring near the road.

As described in Section 2.3.9.1, the use of large diameter culverts has not been very successful on the North Slope due to long-term thermal stability issues, difficulty of construction, and load carrying capacity issues. Therefore, current road construction practice is to utilize available line pipe, usually up to 60 inches diameter, as culverts in place of corrugated metal culverts. Line pipe culverts have more structural strength and a much better record of survivability and service.

The most southern portion of the proposed CD-4 Road goes through Lake 9323 before joining the CD-4 pad. During breakup, Michael Baker (2003) notes that, depending on breakup flooding conditions, recharge into this lake has occurred from both the Sakoonang and Nigliq Channel sub-basins. Thus, an approximately 400-ft section of the CD-4 road, will require a crossing structure (either a bridge or culvert battery). The lake water is 8 feet-deep at the crossing location and shallower along the road alignment (see Figure 2.4.1.1-3). A culvert battery is proposed but it will need to have adequate capacity to maintain this recharge potential and at the same time minimize impacts to fish habitat and allow free movement of fish in the lake. Fish passage to Lake L9323 from the Nigliq Channel and from the Sakoonang Channel (via Lakes L9324 and M9525) would be maintained by routing the road across the center constriction of the lake and maintaining floodwater paths from both the east and west.

At CD-4, the structure and function of low-lying, high-value wetlands has been evaluated and would be maintained because the access road has been situated on high ground that would not be expected to affect flow associated with a 5-year flood event (Michael Baker, Jr. Inc. 2004a).

Final design of the culverts for the CD-5, CD-6, and CD-7 road will depend upon break-up information for those drainages that could impact the roads. However, these crossings are not expected to present any technical or engineering challenges beyond what is currently practiced on the North Slope.

Impacts Related to Bridges

Nigliq Channel Bridge

At the proposed bridge crossing, the Nigliq Channel is approximately 1,550 to 1,600 ft wide and flows north with its thalweg along the west side and a floodplain on the east side. Although the west bank is actively eroding (primarily due to thermal degradation) it is more defined and steeper than the east bank, which grades less distinctly with the higher less active floodplain to the east. Because the active channel is over 1,200 ft wide, the channel would be constricted somewhat at the proposed 1,200-foot bridge location, thereby slightly increasing velocity through the structure during flood flows. Various flood frequencies, their effect on depth and velocity of water in the channel, and depth and volume of sediment scour were examined.

In general, localized scour associated with bridge supports is only expected to occur during a flood with a recurrence interval greater than 10 years (J. Pickering, 2004). Figure 4A.2.2-16 illustrates the amount and depth of scour caused by changes in water surface elevation during a 200-year flood. Figures 4A.2.2-19 and 4A.2.2-20 illustrate respective project and bridge scour depths and amounts caused by changes in velocity during the 200-year flood. Scour depth ranges up to 20 feet, and is greatest right under the bridge. Scour is even deeper around each bridge pier (i.e., likely an additional 5 ft). These scour estimates assume the channel is non-frozen silt and that scour will occur uniformly across the entire channel. However, as noted above in the subsection – Scour Analyses, the grain-size and thermal character of the channel substrate is variable, so that scouring may not be uniform but preferentially deeper in the sandy non-frozen thalweg, where water depths and velocities will be greatest.

Scour will likely occur in episodic cycles during major flood events followed by more steady rates of sedimentation. The volume of scour attributable to the bridge is estimated to be less than 1 percent of the total suspended load during flood flows (Pickering pers. comm. 2004). Because much of channel bottom sediments are fine-grained they will stay suspended during the breakup flood and be deposited on sea ice. However, a significant portion of the scoured material is sand, which will not remain in suspension, but will be deposited a short distance downstream of the bridge where the high flow velocities would be attenuated. Although the locations and mechanisms of sediment transport have not been studied, the natural sediment load of the Colville River is relatively high. Some aquatic habitat may be impacted by sedimentation, but this will likely be typical of the biophysical system. Additional channel maintenance (i.e., dredging) for navigation or fish passage once the bridge structure is in place is not anticipated. Nevertheless channel monitoring should be utilized to assess the need to maintain channel navigability and fish passage during low water conditions.

A recent analyses of historical bank erosion along the Nigliq Channel was conducted by Michael Baker and Hydroconsult (2004). Various measurements of bank erosion have been made along the Nigliq Channels. A one-time maximum erosion occurrence of 36 feet was measured by Walker et al. (1994), which resulted from the collapse of a thermo-erosional niche. Michael Baker (2004b) suggested that the characteristics of the proposed bridge location are such that a one-time erosion occurrence is likely to have the same magnitude as the observed maximum occurrence.

Walker et al. (1994) also concluded that erosion along the Nigliq Channel is variable from year to year and from location to location. Even for very specific locations, such as a sharp bend at Nuiqsut, the bank erosion at the bend varied from less than 0.7 feet per year to 36 feet in 1 year. In 2003, ABR completed a study of erosion based on photogrammetric analyses of 1955 and 2001 air photos along a 1 kilometer stretch of the west bank of the Nigliq Channel. It was concluded that the erosion rate of the west bank at proposed bridge location was 1.8 feet per year with a maximum of 2.1 feet per year over the 46-year period. Michael Baker Jr. Inc. (2004b) used aerial photography to compare 1948 and 1999 bank lines. The results compared well with the ABR investigation, concluding that the erosion rate of the west bank at the proposed bridge location averaged 2.2 feet per year over the 51-year analysis period.

It can be conservatively assumed that erosion rates comparable to historically documented values will occur in the vicinity of the proposed bridge, such that continued erosion of the west bank would cause the west abutment to lie further into the channel. Bridge construction and design components can be used to minimize or eliminate bank erosion and minimize the effects of this erosion. It is not known whether factors that promote erosion will be transferred and increase erosion in other areas, but this is also a possibility.

Ublutuoch River Bridge

Under Alternative A, a 120-ft bridge is proposed for the Ublutuoch River at river mile 6.9. CPAI engineers developed rating curves based on measured water surface elevations and discharge (in the presence of ground-fast ice) to predict the elevation of backwater created by various bridge lengths (Michael Baker, Jr., 2003-Attachment 1). From the rating curves, bridge height was determined. The proposed 120-ft bridge was designed to span the main channel and the lower west floodplain (specifically, from bank to bank) and be considerably above the 100-yr water surface elevation. The roads approaching the bridge would be required to provide for natural flow. Although the higher west floodplain is inundated during high flows and spring breakup, it does not convey a significant percentage of the total flow due to its elevation. Rather, flow is conveyed along the lower west floodplain and the main channel, but with the presence of ice jams during moderate to large floods backwater could result.

Other than the HEC-RAS calculation of backwater with a 120-ft bridge scenario described above, no hydrologic or hydraulic analyses on the Ublutuoch River bridge were conducted. Water velocity would be expected to vary somewhat from baseline conditions because the channel and lower west floodplain would be constricted; ice jams would only contribute to this effect. Similarly, channel scour and streambank erosion would not be similar to baseline conditions since velocity and flow patterns would change as a result of bridge construction. Appreciable ice jamming, a consideration for the piles, abutment, and height of bridge, is possible with the lower west floodplain alternative flow route (depending on flood level).

Other Bridges

At the major crossings, depending on design attributes, flow would likely be restricted to less-frequent-to-rare high flows, suggesting that a bridge is needed (e.g., at the minor crossings west of the Delta along the National Petroleum Reserve-Alaska Road). It is assumed that constriction will restrict flows at all of these crossings. During flow constriction stream velocities slow upstream and water levels rise (backwater effect) while stream velocities increase in the constricted areas. This could result in increased potential for scour and streambank erosion. This may indicate the need for greater armor or a longer bridge that reduces the effects of the constriction and minimize scour and erosion processes. The potential for these impacts would be reduced by appropriate mitigation incorporated into the bridge designs.

Impacts Associated with Production Pads

Natural drainage patterns can be disrupted when activities associated with production pad location and/or use block, divert, or impede flow of active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Production pads will not be placed in streams. The potential impacts occur during the operations period, but are best avoided by design considerations prior to construction. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. These effects are minimized by incorporating construction mitigation and design features into the pads to protect the structural integrity of the pads and minimize the effects of pads on natural flow processes.

CD-3 through CD-7 and their associated roads were sited to minimize impacts to wildlife, fish, and vegetation, while maintaining a technically and economically feasible project. As much as possible, production pads have also been located to minimize effects on streams and/or drainages. Design criteria are developed to eliminate or minimize the potential for impacts to these facilities and potential impacts from pad development. These criteria, described in Section 2.3.3.1, include more stringent design features for those facilities on the Delta (CD-3 and CD-4) than those on the Coastal Plain. Other pad locations were primarily determined assessing how best to minimize affects on wildlife habitat.

CD-3

CD-3 and CD-4 were studied in detail (e.g. flood frequency and production pad height) in 2001 and 2002. This information was used to develop pad height criteria. However, both CD-3 and CD-4 pad heights are governed more by thermal criteria than by flood criteria. The results of the 2D open-water modeling for various flood frequencies are compared to CD-3 pad design criteria on Figure 4A.2.2-37. CD-3 pad proposed elevation is 12.6 ft BPMSL, which is 4.2 ft above the predicted 200-year (1,000,000 cfs) flood elevation, and 3.7 ft above the 1,300,000 cfs level, so designed with sufficient freeboard.

The proposed CD-3 location is approximately 8 kilometers north of APF-1. The drill site location will be adjacent to Lake M9313 and placed on the highest terrain in the area between the West Ulamnigiaq and East Ulamnigiaq Channels on the Delta. This is an area where infrequent but high-magnitude flood events can potentially occur. The pad would not affect fish passage to Lake M9313 because the site is situated away from the primary route of fish passage (see Section 4A.3.2).

Further, based on the results of the preliminary analyses conducted by Michael Baker Jr. Inc. (2002b), storm surge would not produce a higher water surface elevation than a river flood, with a similar risk of occurrence. The effect of a fall flood concurrent with a storm surge would have a smaller effect than the effects encountered during break-up, because the flows are much lower than spring flows. Observed storm surges and hindcast analysis indicate that these big storms occur in late summer and fall, and thus they are unlikely to coincide with break-up. These late summer/fall storm surges could affect CD-3, but streams are at their lowest level at that time and thus it will not likely be an issue.

CD-4

The proposed CD-4 location and pad heights were arrived at by considering thermal stability and hydrologic factors that include ensuring that cross drainage problems during flooding would not be an issue. Flooding could result in adverse impacts to fisheries using adjacent lakes and connections because of the potential for gravel eroding into the waterways. The pad location is situated to maximize access to the reservoir and is located between Lakes L9323 and L9324, on an abandoned floodplain cover deposit. The decision to construct the road across Lake L9323 was made in order to move the road away from the pipeline racks to the east, thereby facilitating crossing by caribou. Research indicates that pipelines and roads should be separated by at least 350 feet to enable crossing, and this area has been identified as an important area for east–west travel by caribou.

CD-4 is not expected to change the hydrologic regime significantly in the area. The results of the 2D open-water modeling for various flood frequencies are compared to CD-4 pad design criteria on Figure 4A.2.2-35. The proposed CD-4 pad elevation is 19.0 ft BPMSL, which is 4.8 ft above the predicted 50-year (730,000 cfs), 2.3 ft above the 200-yr (1,000,000 cfs), and 0.3 ft above the 1,300,000 cfs level, so designed with sufficient freeboard, Water velocities during the 200-year flood are likely to be relatively slow (on the order of 1 foot to 2.5 fps) on the floodplain near the proposed facility (MBJ 2004a).

CD-5

CD-5 would be located more than 1 mile from the nearest lake or stream and on relatively flat, high ground, so impacts to surface water are unlikely. Nevertheless, rare overland flows during break-up could be widespread across the tundra and could isolate the pad from the access road for small time periods.

CD-6

CD-6 would also be located on relatively flat ground along a small topographic divide, but within the 3-mile no permanent facilities stipulation. Depending on where the measurement is taken, CD-6 would be about 1.3 to 2 miles from Fish Creek, about 1,800 feet from a small unnamed tributary to Fish Creek, and about 2,600 feet from a small lake. Other than these water bodies, no others are within 0.5 miles of the facility, so direct impacts to surface water bodies from this facility are unlikely. The setback stipulations are meant to protect fish and wildlife within the 3-mile corridor, and not related to hydrologic considerations.

CD-7

CD-7 would be located approximately 8.5 miles southwest of CD-6, and south of the 3-mile no permanent facilities stipulation. The production pad would be located near an apparently dry basin and not near any rivers or streams that would undergo break-up flows. One concern is that during high water years the old lake may fill and may ultimately overtop and spill toward Fish Creek. Water level data was collected in the vicinity of CD-7 at Lake M0024 in 2002. Outflow from Lake M0024 towards the dry lakebed was estimated at 45 gallons per minute (gpm) in September 2002. Water surface elevations suggest that M0024 was recharged to the point of overflow in 2002. This type of monitoring should be continued if the proposed CD-7 is incorporated.

CD-7 would be located more than 0.5 miles southwest of an area with many moderate-sized and small lakes. During periods of high water in spring and fall, waters near the production pad that would collect in the dry basin would flow into downstream lakes and ultimately into Fish Creek. Future monitoring of water level conditions and flow paths during spring break-up in the drained lake basin is needed to minimize the potential risks to CD-7 and downstream waters.

The site is located in an area of flooded and saturated ground described as a wet meadow and young basin wetland complex. The two habitats have low to high values for waterbird nesting, but no nests were found within 200 meters of CD-7's center point. However, nests were found in areas as near as 1000 feet. The route to CD-7 was selected to avoid wet and thaw-unstable areas and to avoid approaching the surrounding wetlands that appear to be productive nesting areas. A preliminary road route, between the wetland basin where CD-7 is proposed, and the deep lake immediately to the east, was not recommended because it would separate a loon nesting lake from a brood-rearing lake, access to which is required for successful fledging of young loons. Moving CD-7 to within the basin would probably be detrimental, because it would likely be nearer to waterbird nests. Thus, the pad location is optimal for minimizing environmental impacts, while meeting minimum economic considerations.

Break-up typically occurs as a flood event and, combined with ice and snow damming, can flood large areas of the tundra (i.e., overland flow). Thus, even though the proposed locations for CD-5, CD-6, and CD-7 are relatively remote from streams and placed on relatively high locations, when feasible, design criteria to address spring break-up overland flows have been incorporated into the production pad designs.

Impacts to Estuaries and Nearshore Environment During Operation

Because most of the production pads, roads, and pipelines are not near the coast, no direct impacts to the physical conditions or processes within the estuarine and nearshore environments would be expected. Storm surges and wave action, however, could affect the operation of some of the proposed facilities. CD-3 is located approximately 3 miles from the nearshore environment. Storm surges from Harrison Bay produced by sustained westerly winds concurrent with late summer high flow events could bring sea water flooding inland and result in flooding in the vicinity of CD-3. Evidence of historic storm surges is shown by the driftwood lines that are found a number of miles from the coast, including as far inland as CD-3. While it is evident that storm surge waters have reached as far inland as CD-3, such occurrences are likely infrequent and typically produce flooding impacts comparable to relatively moderate-sized break-up floods.

Coastal Frontiers (2002) examined the potential water level increases due to Arctic Ocean storm surges and waves at CD-3. They used the discrete spectral wave model, STAVE (Resio, 1988) to simulate wave conditions for four combinations of wind and flood events. The model incorporated refraction, shoaling and diffraction effects on wave propagation, along with wind input, wave spreading, non-linear wave interactions and bottom friction. They used the 1997 topographic grid developed by Shannon & Wilson (1997) and updated by Michael Baker (1998) for the 2D surface water model on a 200-ft by 200-ft rectilinear grid. For wind data, they relied on design basis wind speeds developed for the Endicott Project from Oceanweather and Tekmarine (1983). Similarly, they developed wave input data based on hindcast analyses for the Alaska Beaufort Sea (Oceanweather, 1982).

Coastal Frontiers (2002) concluded that at the CD-3 pad site, the still water levels associated with the 200-yr river flood were comparable to those accompanying the 200-yr coastal storm: +7.7 to +8.2 ft during the flood event, and +8.1 during the surge event. The near-equivalence suggested that the pad site would be located in a transition between surge-dominated from the north and flood-dominated from the south. Further, the 200-yr coastal storm (i.e., 200-yr storm surge with the 1-yr westerly wind) produced the severest wave conditions, with maximum heights of 1.2 ft above the still water surge-flood level occurring on the west-facing portion of the pad and runway. Since the CD-3 proposed pad elevation is 4.2 ft above the 200-yr flood level, then the coastal storm including wave conditions would put the pad about 3.0 ft above the waves. Although these results show the pad elevation and criteria to be sufficient, they should be used with caution, because they were developed using weather and ocean-storm input data that is more than 20 years old.

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years (Lynch et al. 2003). These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic, but apparently not yet in the Beaufort Sea. Observed storm surges and hindcast analysis indicate that these big storms occur in late summer and fall rather than in spring, and thus they are unlikely to coincide with break-up.

From studies conducted by the Office of Naval Research, U.S. Arctic Research Commission (2004), there is considerable debate over whether recent changes in arctic climate are a natural feature of cyclical variability or whether a permanent change is being observed due to global warming. The following scenario is one plausible outcome with an appreciable probability of occurring. Over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing. This indicates that the data used by Coastal Frontiers (2002) may not sufficiently represent the conditions that will prevail during most of the project lifespan. Updating the storm surge analyses using plausible weather and open-water sea conditions would improve the ability to minimize any climate change effects in the future.

Any floods with accompanying waves that cause high water surface elevations at CD-3 could result in an increase in erosion if bank stabilization measures are not adequate. Impacts might include increased erosion of CD-3, its airstrip and approach road, as well as resultant deposition of sands and gravels on the tundra. The gravel deposition could impact nesting and brood rearing areas for birds. This could then potentially result in increased sedimentation lower in the Delta and in the nearshore environment.

The applicant’s previously permitted design criteria built structures meant to withstand the 50-year flood interval +3 feet inside the Delta (bridges and roads); the 200-year flood interval +1 foot inside the Delta (pads); and the 50-year interval outside of the Delta. Understanding and evaluating the causes of flooding from break-up, storm surges, or rainfall events is intrinsic to analyzing specific flood recurrence criteria. The applicant intends to follow these design criteria for future structures, or to base the design on a balance of hydrology, topography, structural stability, economics and environmental protection.

Impacts Associated With Ice Conditions

Pipeline and road bridges, and road culverts, can cause flow constrictions during flood events, which can exert extraordinary stresses on structures. The build-up and impact of ice, especially during the larger-magnitude floods, can exacerbate this condition. Current conceptual bridge and culvert designs have taken ice build-up and ice forces into account, in an attempt to reduce the potential for increased stresses on bridge abutments, increased scouring of bridge supports, increased side slope erosion, and overbank flows onto roads, as well as fish passage at times of increased flow (CPAI 2004).

The impacts associated with ice conditions are more fully described and analyzed in a previous subsection called Ice Effects. The main conclusions from this analysis was that based on approximately 10 years of observations of breakup conditions on the Delta and a hypothetical ice-jam modeling exercise, the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small (Michael Baker, 2004d). In general, Michael Baker (2004d) stated that when water depths and topography of the Delta during flows are greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a “worse-case” location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations at Alpine will be exceeded by floodwater even when ice-jamming conditions are considered.

Potential negative effects to gravel structures, culverts, bridges, and pipelines from ice jams and break-up could occur due to increased flood stages and velocities, increased potential for overtopping (from wave run-up), and side-slope erosion. The structural integrity and design of the proposed facilities will be analyzed using conservative estimates of these influencing factors. Conservative assumptions regarding preliminary bridge design concepts indicate that there is a potential for ice jams. These could result in damage to or failure of facilities and cause increases in erosion and sedimentation.

The likelihood of failure of pipeline, road, or structures due to ice conditions is minimized by conservative designs. Continued monitoring of these bridges, pipeline VSMs, road embankments, and culvert crossings will help to mitigate against potential structural failures and improve subsequent designs. The requirement for continued incorporation of design improvements based on monitoring reduces the likelihood of ice-related impacts.

ABANDONMENT AND REHABILITATION

Removal of facilities, particularly roads, bridges, and culverts, would likely cause subsequent increased sedimentation and erosion. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance would result in long-term, higher levels of erosion, sedimentation, and upslope impoundment. Leaving the roads in place, but removing bridges and culverts, and breaching the roads where culverts had been placed, would reduce upslope impoundment. Ponds would be formed from melting of ice wedges or other ice underlying the gravel facilities. In the case of roads and the CD-3 airstrip, these ponds would be linear. Cleaning the pipeline would create a large, one-time demand for water.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT PLAN IMPACTS ON WATER RESOURCES

Various hypothetical facilities under Alternative A – FFD are distributed throughout the National Petroleum Reserve-Alaska area and the Colville River Delta, and, as a consequence, roads and pipelines would cross many drainages within the Colville River, and the Fish–Judy Creeks and Kalikpik–Kogru Rivers Facility Groups. Production pads could be located adjacent to lakes and stream channels. The impact analysis for Alternative A – FFD is conceptually no different from Alternative A – CPAI Development Plan, except that area covered is much larger. This means that the impacts and design features described above for Alternative A will be relevant here. Table 4A.2.2-9 summarizes potential construction and operation impacts to water resources from the 22 HPs and HPF-1 and HPF-2.

It should be noted that no hydrological modeling associated with Alternative A – FFD has been undertaken. The results of existing two-dimensional modeling of the Colville River Delta (Michael Baker 2004a) conducted for Alternative A cannot realistically be used to evaluate the effects of Alternative A – FFD, simply because of its associated large increase of facilities on the Delta. Thus, the additive effects of roads altering the hydrology in the Colville River Delta, and the potential impacts associated with a road system (and airstrips) could be quite substantial. Further, in the western portion of the FFD, only scant hydrologic baseline data is available (i.e., some lake depth and geomorphic characterization, but no streamflow observations/monitoring or hydraulic assessments/modeling). In general, the impacts associated with Alternative A – FFD are not well understood, but must be assumed to be significantly greater in magnitude and extent than the effects of Alternative A – CPAI Development Plan.Alternative A – Summary of Impacts (CPAI and FFD) on Water Resources

IMPACTS TO SUBSURFACE WATERS

Groundwater resources in the North Slope are rare and primarily shallow. Sparse data indicate that sub-permafrost groundwater is brackish to saline, rendering it non-potable. The permafrost forms an aquiclude that prevents the mixing of sub-permafrost and supra-permafrost groundwater. Therefore, the proposed deep groundwater injections associated with Class I and/or Class II wells are not expected to affect the quality or quantity of shallow groundwater.

Under Alternative A – FFD, it may be beneficial to incorporate into the current design an underground injection line at each production pad, as the potential need for additional Class I and/or Class II Well(s) may arise at some future date. As a result, specific localized deep groundwater zones could be adversely affected by the practice of disposing of drilling wastes and wastewater into development or disposal wells. Although this practice would affect more groundwater zones throughout the Plan Area, because groundwater below permafrost is typically saline, impacts to potable water sources are not expected. As a result of the increased number of pads and facilities, there will be an increase in the required number of Class I and Class II Wells. Permits will be required as per specific SDWA regulations. Additional data would be collected at all potential injection well locations before approvals are issued for additional injection wells.

The proposed alternative and FFD-A requires that gravel quarries will be mined. As described above for the proposed CPAI Development Plan (Alternative A), each new gravel mine would eliminate shallow taliks and supra-permafrost water zones; however, the effect of this loss on water resources would be negligible, because the area would be very local in extent. Although rehabilitation would include allowing natural flows to fill the mine-site excavation, the subsurface water-bearing zone would be permanently eliminated. Thus, in effect the ‘pond’ habitat will be in exchange of the original tundra habitat.

IMPACTS TO SURFACE WATERS ASSOCIATED WITH WATER SUPPLY DEMANDS

Lakes would be the principal freshwater supply for the construction of ice roads and pads during the winter seasons, during production drilling and processing operations, and for potable water at temporary construction or drilling camp facilities. This demand would be dispersed over time and across the road corridors where there are numerous lakes. In general, long-term (longer than 1 year) impacts on lake-water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes each year.

Demands of Alternative A – FFD on the water supply would be approximately four to five times those associated with Alternative A. These demands (i.e., more lakes needed to supply water for ice road construction, potability, etc.) would be dispersed over time and across a broad area where there are abundant lakes. Therefore, impacts are not expected to be any greater than for those associated with Alternative A. Lakes would still be the principal fresh water supply for the construction of ice roads and pads during the winter seasons, during production drilling and processing operations, and for potable water at temporary construction or drilling camp facilities. The use of Colville River water is also a possibility, but its use would be restricted to certain times of the year (due to high suspended sediment in the spring and fish requirements during low water conditions, but this would not be a major source of water). In general, long-term (longer than 1 year) impacts on lake water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes (Michael Baker, 2002).

For both Alternative A and FFD-A adequate monitoring and adherence to pumping regulations would limit impacts on lake-water levels to short-term duration. Future monitoring is recommended and should continue to measure lake-water levels through time and provide estimates of recharge and surplus volumes in specific lakes targeted for supplying demand. Data from such monitoring and other future studies would be integrated with assessments of impacts on lake habitat to determine if modifications of permit stipulations are necessary (for example, changes in water withdrawal limitations, additional water quality monitoring, changes to existing lake observation programs, etc.). The applicant will likely conduct monitoring in conjunction with permit requirements associated with appropriate government agencies.

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative A – Full-Field Development														
Colville River Facility Group	**Groundwater**		**Lakes**		**Major and Minor Stream Crossings**								**Estuaries and Nearshore Environment**	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Sakoonang Channel	Tamayayak Channel	Ulamnigiaq Channel	Elaktoveach Channel	Kupigruak Channel	Colville River	Minor Streams	Colville River Delta Mouth	Harrison Bay
HPs 4, 5, 7, 8, 12, 13 and 14														
Gravel Road Segments: CD-4 to CD-7; HP-1 to HP-4; CD-2 to CD-7; HP-1 to HP-5; HP-7 road to airstrip; HP-12 road to airstrip; HP-13 road to airstrip; HP-14 road to airstrip	8	NI	NI	NI	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	NI
Ice Roads: HP-7, HP-12, HP-13, and HP-14	NI	NI	NI	NI	NI	NI	3	3	3	3	3	3	1, 2, 3, 4, 5, 6, 7	NI
Pipeline Segment: HP-4 to CD-4;HP-4 to CD-2;HP-7 to CD-3 (1 pipeline); HP-12 to HP-7; HP-13 to HP-12; HP-14 to HP-12	NI	NI	NI	NI	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	NI
Production Pads: All HPs	8	NI	8	8	2, 3	2, 3	2, 3	2, 3	2, 3	2, 3	NI	2, 3	2, 3	NI
Airstrips: HP-7, HP-12, HP-13, and HP-14	8	NI	8	8	2, 3	2, 3	2, 3	2, 3	2, 3	2, 3	NI	2, 3	2, 3	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – Full-Field Development										
Fish and Judy Creeks Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish Creek Basin	Inigok Creek Basin	Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
HPF-1 and HPs 1, 2, 3, 6, 9, 10, 11, 15, 16, 17, and 19										
Gravel Road Segments: HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	8	NI	3, 5, 6, 7	3, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	NI
Pipeline Segment: HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	NI	NI	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	NI
Production Pads: HPs and HPFs	8	NI	8	NI	2, 3	2, 3	2, 3	2, 3	2, 3	NI
Processing Facility: HPF-1	8	NI	NI	NI	NI	NI	2, 3, 4, 5, 6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – Full-Field Development								
Kogru–Kalikpik Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes & Ponds	Large Deep Lakes	Kalikpik River Drainage	Kogru River	Minor Streams	Harrison Bay
HPF-2 and HPs 18, 20, 21 and 22								
Gravel Road Segments: HP-18 to HPF-1; HP-20 to HPF-2/HP-18 road; HP-21 to HPF-2; HP-22 road to airstrip; HPF-2 to HP-18; HPF-2 road to airstrip	8	NI	3, 5, 6	3, 5, 6	2, 3, 4, 5, 6	NI	2, 3, 4, 5, 6	NI
Ice Roads: HP-22	NI	NI	NI	NI	NI	3, 4, 5, 6	3, 4, 5, 6	3, 4, 5, 6
Pipeline Segment: HP-18 to HPF-1; HP-20 to HPF-2/HP-18 road; HP-21 to HPF-2; HP-22 to HP-21; HPF-2 to HP-18	NI	NI	NI	NI	2, 7	2, 7	2, 7	NI
Production Pads: All HPs and HPFs	8	NI	NI	NI	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	NI
Airstrips: HP-22, HPF-2	8	NI	NI	NI	3, 4, 5, 6	3, 4, 5, 6, 7	3, 4, 5, 6, 7	NI
Processing Facility: HPF-2	8	NI	NI	NI	3, 4, 5, 6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

Notes:

1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages and velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI =No Impact

These monitoring programs should be developed by the applicant, reviewed by appropriate government agencies, and incorporated into licenses and permits for specific representative areas within the Plan Area. These programs should develop strategies to measure lake-water levels through time and provide estimates of recharge and surplus volumes. These programs should also be integrated with assessments of impacts on lake habitat.

IMPACTS TO SURFACE WATER CONDITIONS AT GRAVEL MINES

Upon completion of gravel extraction activities from the proposed Clover A Mine Site, the site will be rehabilitated. The preliminary rehabilitation plan (Appendix O) calls for the creation of a high-value waterbird habitat from the gravel pit. The area of the flooded mine pit is expected to be approximately 60 acres, with a maximum lake depth of over 50 ft. The flooded mine may alter the thermal regime of the permafrost beneath and adjacent to the waterbody and likely impact the steep side slopes. Maintaining a stable water level within the excavated area will be critical to the success of the rehabilitation. The main source of recharge water will come from snow capture (through drifting), snowmelt, and through recharge from overbank flooding from the Ublutuoch River and an existing nearby ephemeral drainage during spring breakup.

The rehabilitation plan calls for two years of monitoring following the completion of the restoration design and after the rehabilitated pit has filled with water. Monitoring plans include inspecting of the pit margin for erosion and instability. This would also include any signs of inflow or outflow erosion.

In general, any new surface water bodies created by the mine pit excavation in both Alternative A and FFD-A would be left to recharge naturally during high flows in natural streams and man-made channels during annual spring break-up floods. Impacts would be mitigated by providing for appropriate fish passage (for example, during spring flows) into and out of these small lakes to nearby water bodies or the maintenance of a lake deep enough for over-wintering. Further, attempts would be made to minimize thermal erosion and degradation or lake shorelines, channel and bank erosion associated with lake inlets and outlets, and maintain natural conveyance characteristics of the terrain. These details would be described in mine and reclamation plans.

SUMMARY OF HYDROLOGIC ANALYSIS AND MODELING IN SUPPORT OF THE IMPACT ASSESSMENTS

In support of the proposed action, various hydrologic analyses and modeling have been conducted to assess the effects of roads, pads and bridges. The results of these evaluations in conjunction with recent experiences with the existing Alpine development has been used to develop conceptual, preliminary or detailed designs for the proposed facilities. Concern over the accuracy and uncertainty associated with certain hydrologic issues, however, has led to much discussion and analysis during the DEIS and FEIS review stages. This section summarizes the detailed discussions and analyses of a number of these issues that included assessments of the accuracy of peak flow and design flow estimates, an assessment of flow distribution in Delta channels, the accuracy of the two-dimensional hydrologic modeling of the Delta, an evaluation of spring breakup related conditions, and an assessment of scour analyses.

The following main points summarize issues with respect to the accuracy of the peak flow data record and the development of design flow estimates:

- The accuracy of design flow estimates is based on the length of record and the accuracy of each data point within the record. There are only 15 years of spring breakup peak flow estimates on the Colville River at the head of the Delta. None of these peak flows were measured by direct methods. Some of these annual peak flows were computed using a simplified USGS slope-area method, but the method could not always be explicitly followed because all the required input data were not available. The errors associated with these peak flow estimates computed by the indirect method can exceed 20 percent depending on a number of factors including the ability to accurately estimate: high water lines in ice-effected areas, measuring water surface slope, channel roughness estimation, non-uniform channel conditions (flow expansion), and bed stability. In some cases, these errors may be over 40 percent. In general, computations made from cross-sectional, stage and slope data collected during ice-created backwater conditions (i.e., ice and/or snow in channel, downstream ice jams) may overestimate peak flows. Similarly, extrapolation of stage-discharge ratings during ice-effected flows will also overestimate flows. This suggests that at least some of the peak flows in the data record are overestimated.

- A large flood event was reported to occur on the Delta in 1989. The 1989 peak flow event is not well documented. The flood was observed in only a few locations, rafted ice was observed strewn on floodplains afterwards, and systematic searches for high-water driftlines were observed a few years later, but no direct or indirect discharge measurements were collected. Based on the identification of 26 high-water lines, of which only 17 of the sites could the absolute elevation be established to ± 1.0 ft, and the use of the two-dimensional model, the peak flow was estimated to be 775,000 cfs with a range from 665,000 to 930,000 cfs. Further, the return period of the event was estimated to be on the order of a 100-yr event, but with a possible range from 67 to 393 years. Based on the high uncertainty associated with the estimation of the 1989 peak flow, the calculated flow value of 775,000 cfs should not be relied on for use in flood frequency assessments, calculations and regressions.

- Using the available peak-flow database, design flows for Alpine area were computed for the 50-, 100- and 200-yr flood values to be approximately 470,000, 730,000 and 1,000,000 cfs, respectively. The 95 percent confidence limits for these values indicate that the flood estimates for the infrequent events have an appreciably larger margin of error (i.e., approximately 50 percent for the 200-yr) than the more frequent events (i.e., approximately 24 percent for the 5-yr). Based on the analysis of reported peak flow stages and the discharges described above, there is the likelihood that some of the peak flows have been overestimated which may have introduced bias into the short-term record used to compute the estimates for the 200-yr, 50-yr and 10-yr flows, such that the re-computed design flows would be less after accounting for the overestimations.

- To put these confidence limits in perspective, calculated 200-year unit runoffs for sites in northern Alaska range from 30 cubic feet per second per square mile (cfsm) to over 70 cfsm. The calculated unit runoff for the Colville River assuming the proposed 200-yr of 1,000,000 cfs is 48.4 cfsm, similar to the other values in the coastal plain area largely because the value was calculated using principally the Kuparuk River (a smaller river located to the east of the Alpine area) data record. For comparison, at discharges of 770,000 and 1,300,000 cfs the unit runoffs would be 37.3 and 62.9 cfsm, respectively, and both are within the observed range for the northern Brooks Range.

- To account for these variations, the 2D model was run at a higher flow of 1,300,000 cfs, to assess the possible effects of underestimating the 50-yr and 200-yr flood values, and to address the reasonableness of freeboard values. These results are presented as rating curves and evaluated at specific locations for each facility or point of interest along the proposed and existing roads.

The location of existing and proposed Alpine facilities lies within the western portion of the Delta with flow dominated by the Nigliq Channel system. Surface conditions on the Delta are by nature complex, governed by the interaction of hydrologic, geomorphic, biologic and thermal processes. Predicting hydrologic conditions in support of designs is much more difficult than with rivers with only single reaches. In this case because of the existing and proposed developments in the west Delta, it is very important to understand what governs the proportion of flow into the Nigliq Channel, and how this flow proportion changes over time based on stage and channel geometry. The following main points summarize issues with respect to the assessment of the flow distribution between the Nigliq and East Channel and how this might effect model accuracy:

- Historical photos and observations indicate that the channel and floodplain geometry at the entrance to the Nigliq Channel has changed over time due to upstream and downstream erosion and sedimentation processes. Further, as the depth of flow changes the conveyance capacity of the channels also changes. These factors cause the proportion of flow carried by the Nigliq Channel to change over short-term and long-term periods. Measured proportions of Monument 1 flows in the Nigliq (at entrance) range from 3.8 to 38.2 percent for flows of 17,100 and 233,000 cfs, while the model predicts the proportion to have a much smaller range (19 to 24 percent) at high flows, 470,000 to 1,000,000 cfs.

- The entrance of the Nigliq, because of its location of divergence of the Colville River, is an area of reduced velocity and naturally occurring deposition (i.e., bankfull channel widens, slope flattens, and deposition results). This suggests sedimentation will continue near the entrance to the Nigliq Channel. Whether this process is manifest during high magnitude infrequent flood events is possible, but not definite. Based on flood conditions (i.e., locations of ice jams during breakup), the extreme flows may just as readily scour out the entrance and open up the channel and cause deposition in another location.

- Part of the uncertainty is due to a lack of continuous discharge data for the main Delta channels in addition to knowing that the natural processes are very dynamic. The ability to predict how the delta will evolve over the next 20 to 50 years is also problematic and hampered by our lack of delta-wide observations, a good long-term aerial photographic record, a comprehensive understanding of spring break-up dynamics, and an understanding how future climate conditions may change.

- Due to ice jams, breakup flows could cause the Nigliq Channel to carry a much larger proportion (i.e., possibly over 50 percent) and very low flows could carry less than one percent simply because the change in channel capacity with elevation is not linear (i.e., more capacity becomes available in subordinate channels at slightly higher elevations). The possibility of this condition and its effects are summarized below when addressing ice effects.

- The current design for the 1,200-ft bridge is based on a 200-yr maximum flow of approximately 213,000 cfs. Although, the likelihood that Nigliq Channel flows would exceed this are extremely low, it is important to understand the conditions that could cause flows to be greater than 213,000 cfs at the bridge crossing so that the current preliminary designs can be considered sufficiently conservative. The result of underestimating Nigliq Channel discharge during high flows can have substantial impacts including increased scour, erosion and sedimentation at bridge and pipeline crossings, and increased water surface elevations around proposed and existing road, pads and runways. Based on analyses described in the FEIS, there are three conditions associated with the Nigliq Channel flow proportion that must be considered in assigning freeboard: ice-jam effects, short and long-term evolution of channel and floodplain geometry, and model inaccuracy.

A two-dimensional surface water model (FESWMS) was used to predict water surface elevations and velocities in the Colville River Delta. The modeling evaluated four Nigliq Channel bridge lengths (900-, 1,200-, 1,500- and 1,650-foot) under varying hydrologic conditions, and predicted water surface elevations and velocities at existing and proposed oilfield facilities. Model runs of the existing and Alternative A conditions were compared for the estimated 10-, 50-, and 200-year recurrence interval floods. These floods are represented by flows estimated to be 470,000, 730,000 and 1,000,000 cfs, respectively, at the head of the Delta, just upstream of the split between the Nigliq and East Channels. With respect to the 2D model, the following findings are relevant:

- The 2D Delta model was calibrated at a flow of 110,000 cfs (i.e., matched observed with predicted water surface elevations) and validated at the higher water surface elevations estimated for the 1989 flood.

- The higher flow conditions as predicted by the model do not have the same level of accuracy as the low flow values. The high-flow predictions could be improved by calibrating the model with measured high flow values, but that due to logistics and the physical constraints related to measuring high flows during breakup, this may not be easily achievable.

- Based on the error observed at 110,000 cfs, computed water levels for higher flows were estimated to have an error of less than 1 foot. This error was used to help establish freeboard criteria for various facility designs. This 1 foot error is supported by the nature of delta topography, in that water surface elevations will increase faster in the channel with increasing flows than outside the channel. Thus, once a flood reaches the floodplain large increases in discharge can be accommodated with very little water surface elevation change.

- The results of the delta-wide model should be used cautiously to depict conditions down to the scale of it’s node-spacing and should not be used to establish flow conditions for designs in specific areas (that are equal to or less than the node-spacing). In these instances (e.g., cross-drainage culverts along CD-4 Road), local hydraulics, erosion, and sedimentation processes will determine the spacing and size of culverts.

Also, the one-dimensional model HEC-RAS was used to predict water surface elevations and velocities for the Ublutuoch River up and downstream of the proposed crossing. Based on the 100-yr discharge estimate for river mile 8.0 (8,900 cfs), the delineated water surface elevations for the 100-yr floodplain. For the 120-ft bridge option, the model predicted the bridge would cause a 0.9 ft increase in the 100-yr water surface elevation.

Current elevation design criteria for facilities (i.e., pads, roads, bridges, etc.) related to the physical environment have not been explicitly developed to consider the effects of ice jams and related ice effects on water surface elevations, but are based on either the prevention of thermal degradation of permafrost (i.e., requiring a minimum pad or road thickness) or on minimizing the risk from open-water flooding (i.e., when ice is not present). Because of the limitations associated with analyses in support of designs (including ice effects), freeboard is incorporated into all the criteria. The issue here is whether the design water surface elevations and freeboard are conservative enough to account for the unknowns associated with predicting the locations, frequency, magnitude and duration of ice jams and flooding associated with ice jams. With respect to the establishing criteria to account for ice effects, the following findings are relevant:

- Several large-scale examples of ice-induced flooding have been observed on the Delta, including the 1974 flood at Nuiqsut, and the 1981 and 2004 ice jams at head of Delta, which apparently changed the proportions of flow entering the Nigliq and East Channels.

- Based on the observations of breakup in the Delta and in conjunction with earlier reports, Michael Baker (2004d) concluded that the effectiveness of an ice jam in creating backwater conditions in the Delta is regulated at some point by the relatively flat terrain in the Delta. Backwater and floodplain inundation from an ice jam will increase the water surface elevation to a threshold defined by channel geometry and topography. This conclusion concurs with theoretical derivations of ice-jam stability (Michel, 1971). Michel describes a physical limit to the thickening of an ice cover under the effect of hydraulic forces. He states that if the discharge is slowly raised under an ice accumulation the cover thickens by shoves until the increase in hydraulic thrust, due to the reduction of flow area, becomes higher than the resistance of the cover to this thrust.

- Michel (1971) mathematically demonstrates that the maximum discharge before shove is directly proportional to the river depth and channel width and inversely proportional to ice and channel roughness. This means that as the discharge reaches a critical water level where either the depth and or width exceed resistance conditions (i.e., overbank discharges), the ice jam tends to release.

- However, Michel also indicates that if the plug or jam is itself sufficiently resistant, water will rise upstream and find an alternate route and bypass the jam. In many cases with dry jams (ice blocking the entire channel), most of the discharge can be deflected, possibly even leading to the formation of a new channel or the occupation of abandoned or less used channels. These conditions, although apparently not frequent on the Delta based on past observations, could occur if breakup was rapid, river water levels increased rapidly, and ice strength was still high.

- The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern.

- Although these conclusions are reasonable and intuitive, the ice jam modeling that supports this conclusion was unable to simulate conditions similar to those in 2004. For example, in the model assumptions (i.e., the size, orientation, and condition - bottomfast versus shorefast and floating - of the modeled ice jam did not result in a significant large re-direction of flow, which was apparently observed to occur in 2004).

- The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta, but much of the dynamics are still not well understood. Therefore, underestimating impacts the model results should be viewed cautiously due to the difficulty in accurately simulating ice jams.

During high flows in the region's streams and rivers, scour can change the channel geometry of areas upstream and downstream of bridges and culverts and affect their structural integrity. Scour analyses have been conducted for the Nigliq Channel bridge site but not for any of the other bridge sites. However, general scour concepts and mitigation measures have been provided. The following main points summarize issues with respect to the evaluation of scour at the proposed Nigliq Channel bridge crossing:

- Soil borings drilled into the Nigliq Channel at the bridge crossing indicate that the channel sediments range from organic-silt, silt, silty sand and sand within the upper 35 feet. The borings also indicate that the sediments contain visible ice in the upper 30 ft of all the boring locations except the main channel boring.

- Based on velocities predicted by the 2D model, and assumptions regarding grain size, channel uniformity and thermal condition of the sediments, the depth of scour was estimated using both Abscour and HEC-18 programs. The results suggested that the 50-year flow would result in a maximum uniform (across the entire channel) scour of approximately 12 feet and the 200-year flow approximately 20 feet at the Nigliq Channel bridge site.

- However, using more conservative assumptions regarding sediment grain sizes, ice conditions, and channel uniformity will result in non-uniform scour, such that the non-frozen loose sands in the main channel may be preferentially scoured, while the partially frozen silts in the floodplain may resist scour. This may result in deeper scour in the main channel and less scour over the floodplain than estimated.

- At the crossing, the main channel and portions of the east floodplain are comprised of sands. These sands will be scoured during higher velocities under the bridge and then likely deposited a short distance downstream of the bridge due to attenuated velocities. The increased sedimentation on the floodplain and main channel could reduce low water conveyance capacity, which could adversely affect navigability and fish passage during very low flows. The scour and sedimentation will occur episodically, resulting in episodic changes in channel characteristics downstream of bridge over the project lifespan.

- Scour at the piers and bridge abutments is a function of flow patterns approaching the structures and shape, alignment and size of the structures. Uncertainties in scour amounts, due to flow and water level uncertainty, are small compared to the potential variability in results due to flow pattern assumptions and techniques available for computing scour. These factors have been considered in the scour analysis for the Nigliq Channel bridge.

- Scour estimates have been conducted for the bridge crossing, and the proposed bridge location and design will incorporate agency comments and continuing analyses. In particular, the ADOT&PF is studying discharge and breakup processes on the Colville River in preparation for the proposal to construct a bridge at the head of the Delta as part of the State of Alaska's proposed Colville River Road project (see Alternative C-2). ADOT&PF will be developing scour estimates associated with design flood values, and their analyses should be considered as an important contribution to developing design conditions for this project.

In general, for each stream crossing only general stream and channel characteristics are known, and only conceptual designs exist, so that the potential for scour must be assumed and appropriate mitigation incorporated in final designs. Since scour-related impacts are possible without sufficient design components, it is conservatively assumed that some scour will occur. Although not likely, this could result in structural failure, additional erosion and downstream sedimentation, and impacts to aquatic habitat. Designs should demonstrate that specific protection from scour and sedimentation has been developed for each crossing, and appropriate mitigation measures (including monitoring and adaptive management scenarios) are incorporated.

IMPACTS TO SURFACE WATERS – RIVERS AND CREEKS – RELATED TO PIPELINES, ROADS AND BRIDGES

Rivers and creeks can be affected when construction and operation activities associated with road and pipelines block, divert, impede, or constrict flows. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Constricting flows can result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. These potential impacts need to be minimized by incorporating design features to protect the structural integrity of the road- and pipeline-crossing structures to accommodate all but the rarest flood events.

Specific designs have been provided for some locations; and conceptual designs for other locations have also been provided. It is assumed conservatively that some impacts might occur. In most cases designs for Alternative A – FFD will be based on from the results of monitoring existing and proposed structures and facilities.

Pipelines

Design features have been incorporated into existing conceptual and/or detailed plans to protect the structural integrity of pipeline-crossing structures from flooding, erosion, sedimentation, scour, ice jams, ice impacts, and storm surges during all but the rarest flood events. The alignment of the proposed pipeline would cross the Nigliq Channel, the Ublutuoch River, Fish Creek, and other small drainages, and would follow a separate alignment 350 to 1,000 feet from the access road, except at the bridge crossings.

Impacts related to flow constriction would be unlikely at the minor pipeline crossings at all flows. The potential for ice jams at the major pipeline crossings is likely similar to that for the bridges. Specific design criteria must be supported by analyses that demonstrate that the VSMs will allow for free passage of ice, and more conservatively account for any additional forces that could damage support structures.

In general, on the Delta and for the major stream or river crossings, pipeline-crossing structures are designed with more stringent standards than road-crossing structures because of the greater sensitivity of the environment to a structural failure. Pipeline-crossing structures are designed to accommodate the 200-year flood (plus 1 foot of freeboard), while road-crossing structures are designed to accommodate the 50-year flood (plus 3 feet of freeboard) (See Sections 2.3.1 and 2.3.2).

RoadsThe proposed road from Alpine to CD-4 is hydraulically fundamentally different than the existing Alpine to CD-2 Road. The CD-2 Road runs east-west and crosses delta channels (i.e., perpendicular to flow), while the CD-4 Road runs north-south (i.e., parallel to flow).

The results of the 2D open-water modeling for various flood frequencies are compared to road design criteria, which states that the road will have to be built to the 50-yr level plus 3 ft for freeboard. The modeling results suggest that for the large magnitude less frequent events the elevation of a few sections of the proposed CD-4 Road (based on preliminary design elevations) may not be high enough, while the existing and proposed CD-2 to CD-7 road is above all criteria. However, design criteria were exceeded at two of the existing bridges.

Bridges

At the proposed bridge crossing, the Nigliq Channel is approximately 1,550 to 1,600 ft wide. Because the active channel is over 1,200 ft wide, the channel would be constricted somewhat at the proposed 1,200-foot bridge location, thereby slightly increasing velocity through the structure during flood flows. In general, localized scour associated with bridge supports is only expected to occur during a flood with a recurrence interval greater than 10 years.

Estimates of scour depth ranges up to 20 feet, and is greatest right under the bridge. Scour is even deeper around each bridge pier (i.e., likely an additional 5 ft). These scour estimates assume the channel is non-frozen silt and that scour will occur uniformly across the entire channel. However, the grain-size and thermal character of the channel substrate is variable, so that scouring may not be uniform but preferentially deeper in the sandy non-frozen thalweg, where water depths and velocities will be greatest.

Scour will likely occur in episodic cycles during major flood events followed by more steady rates of sedimentation. Because much of channel bottom sediments are fine-grained they will stay suspended during the breakup flood and be deposited on sea ice. However, an appreciable portion of the scoured material is sand, which will not remain in suspension, but will be deposited a short distance downstream of the bridge where the high flow velocities would be attenuated. Although the locations and mechanisms of sediment transport have not been modeled, the natural sediment load of the Colville River is relatively high. Some aquatic habitat may be impacted by sedimentation, but this will likely be typical of the biophysical system. Additional channel maintenance (i.e., dredging) once the bridge structure is in place is not anticipated, but may need to be considered. Channel depth monitoring is recommended to assess the need to maintain channel navigability and fish passage during low water conditions.

It can be conservatively assumed that erosion rates comparable to historically documented values will occur in the vicinity of the proposed bridge, such that continued erosion of the west bank would cause the west abutment to lie further into the channel. Bridge construction and design components can be used to minimize or eliminate bank erosion and minimize the effects of this erosion.

Under Alternative A, a 120-ft bridge is proposed for the Ublutuoch River at river mile 6.9. The proposed 120-ft bridge was designed to span the main channel and the lower west floodplain (specifically, from bank to bank) and be considerably above the 100-yr water surface elevation. The roads approaching the bridge would be inundated during very high flows. Although the higher west floodplain is inundated during high flows and spring breakup, it does not convey a significant percentage of the total flow due to its elevation. Rather, flow is conveyed along the lower west floodplain and the main channel, but with the presence of ice jams during moderate to large floods backwater could result.

It is assumed that some constriction will occur at all of the bridge crossings. During flow constriction stream velocities slow upstream and water levels rise (backwater effect) while stream velocities increase in the constricted areas. This could result in increased potential for scour and streambank erosion. This may indicate the need for greater armor or a longer bridge that reduces the effects of the constriction and minimizes scour and erosion processes. The potential for these impacts would be reduced by additional mitigation incorporated into the bridge designs.

Mitigation of these impacts includes the detailed designs for proposed bridge crossings (i.e., on the CD-4 Road), culverts, pads and roads that are supported by comprehensive analyses of impacts associated with these features and based on detailed hydrologic modeling as necessary to characterize flood conditions for various scenarios, including the characterization of model and data uncertainty that considers appropriate and sufficient scrutiny of statistical parameters and engineering risk. Continued data gathering (including some additional programs that are not currently being undertaken: continuous monitoring of water-surface elevations and streamflow throughout break-up, the summer and freeze-up periods for all affected streams) should be undertaken as a mitigation measure. In particular, it is recommended that for those streams with important bridge crossings (the proposed 120-foot bridge on the Ublutuoch River, the 1,200-foot bridge on the Nigliq Channel, and the 80-foot bridge on the paleochannel) a comprehensive data set will enable better characterization of flood frequency, flooding processes, channel conditions, and scour potential.

In the event that floods exceed design criteria, it is likely that natural delta topography and the increase in man-made facilities (including more crossing structures) would slow the flood flows, which would result in more widespread inundation and an increase in erosion and sedimentation across much of the Delta. Flow constrictions and high velocities would still occur at the main channel road and pipeline crossings and increase the potential for localized scouring of crossing structures and erosion of bridge abutment foundations and road embankments. This effect would also occur in the Fish Creek and Kalikpik–Kogru River basins, but to a lesser extent simply because the size of flows in these basins will not be as great, and the floodplains are smaller in area.

Under Alternative A – FFD, roads and pipelines would cross numerous rivers and creeks, and production pads could be situated in locations adjacent to lakes, streams, and rivers. These structures would affect surface waters when construction and operation activities block, divert, impede, or constrict flows. Conceptually, designs of these structures would be similar in scope to that under Alternative A. Thus, recommendations provided for Alternative A also apply to Alternative A – FFD. These include detailed design features for bridge crossings, culverts, pads and roads, and hydrologic modeling as necessary to characterize flood conditions for various scenarios. Pre-existing facilities (i.e., existing and proposed Alpine Delta pads, roads, bridges and pipelines) may be impacted by the building of more crossing structures which would slow the passage of flood flows. It is plausible that conditions that now meet criteria may change so that criteria are not met when the Delta is more fully developed. The 2D open-water model could be used to explore various open-water scenarios to determine how floods are attenuated if FFD Delta development occurs. Further additional data gathering and continued monitoring would be conducted prior to permitting FFD, including impacts to the hydrology of the Delta and the entire Plan Area.

In general, existing data, information, and studies conducted in the areas of the Colville River and Fish–Judy Creeks Facility Group can be applied to developing appropriate mitigation and design elements for road and pipeline crossings and production pads, and the impact analysis described above is relevant here. Very little data and information are available, however, for streams in the Kalikpik–Kogru Rivers Facility Group. In any case, future monitoring programs would need to be developed for representative locations throughout the Plan Area to help develop appropriate design and mitigation strategies. Further, potential impacts would be minimized by incorporating design features that protect the structural integrity of the road- and pipeline-crossing structures to accommodate all but the rarest flood events (i.e., based on specific flood recurrence criteria).

In general, for those roads and pipelines serving the seven production pads in the Colville River Delta Facility Group on the Delta, potential impacts would be greater, so design criteria are more stringent. Further, because there is a greater sensitivity of the environment to a structural failure of pipelines, more care is necessary to locate pipeline crossings. In the rare event when design floods are exceeded, the potential impacts associated with Alternative A – FFD would be greater than those under Alternative A, simply because there are more structures and facilities at risk.

IMPACTS TO SURFACE WATERS RELATED TO PRODUCTION PADS

All proposed production pads have been designed to account for thermal criteria (minimum thickness to prevent permafrost degradation) and hydrologic criteria (200-yr water surface elevation plus 1 ft of freeboard on the Delta, 50-yr flood plus 3 ft of freeboard for CD-5, CD-6 and CD-7). For CD-3 and CD-4, the results of the 2D surface water model indicate 200-yr water surface elevations below the thermal criteria, so that the proposed pad elevations are adequate. These conclusions are based on the open-water delta-wide 2D model that does not account for ice-effected water surface elevations. Michael Baker’s (2004d) recent analysis of ice-jamming also concludes that ice-jamming related effects will not create water surface elevations at the proposed pad locations above the 200-yr flood levels.

Because construction of pads will occur during the winter season, construction-related impacts on flow processes are negligible. Nevertheless, erosion and sedimentation processes could be increased as a result of the potential disturbance of soils/tundra, which would not be realized until break-up when surface runoff processes begin and entrain loosened sediment from disturbed soils.

During operations, the rationale for the locations of pads CD-3 to CD-7 and road placement minimizes impacts on wildlife, fish, and vegetation while attempting to maintain a technically and economically feasible project. As much as possible, pads have been located to minimize effects on streams and drainages. Design criteria are developed to eliminate or minimize the potential for impacts on these facilities and potential impacts from pad development. These criteria include more stringent design features for those facilities on the Delta (CD-3 and CD-4) than those on the coastal plain. Other pad locations were primarily determined by minimizing effects on wildlife habitat.

CD-3 is located approximately 3 miles from the coast. Storm surges from Harrison Bay produced by sustained westerly winds concurrent with late summer high flow events could bring sea water flooding inland and result in flooding in the vicinity of CD-3. Evidence of historic storm surges is shown by the driftwood lines that are found a number of miles from the coast, including as far inland as CD-3. While it is evident that storm surge waters have reached as far inland as CD-3, such occurrences are likely infrequent and typically produce flooding impacts comparable to relatively moderate-sized break-up floods.

The predicted 200-yr coastal storm (i.e., 200-yr storm surge with the 1-yr westerly wind) produced the severest wave conditions, with maximum heights of 1.2 ft above the still water surge-flood level occurring on the west-facing portion of the pad and runway. Since the CD-3 proposed pad elevation is 4.2 ft above the 200-yr flood level, then the coastal storm including wave conditions would put the pad about 3.0 ft above the waves. Although these results show the pad elevation and criteria to be sufficient, they should be used with caution, because they were developed using weather and ocean-storm input data that is more than 20 years old that do not incorporate many of the more recent observations and findings related to climate changes occurring in the Arctic.

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years. These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic. The Office of Naval Research, U.S. Arctic Research Commission (2004) report that although there is considerable debate over predicted changes in arctic climate patterns due to global warming, it is very plausible that over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing. This indicates that the 1970's database used to predict storm surges and waves in region may not sufficiently represent the conditions that will prevail during most of the project lifespan. Updating the storm surge analyses using plausible weather and open-water sea conditions would improve the ability to minimize any climate change effects in the future.

It is conservatively assumed that storm-surge related flooding impacts could occur sometime during the pad's duration. These might include increased erosion of the CD-3 pad, airstrip, and approach road, as well as resultant deposition of sands and gravels on the tundra. The gravel deposition could affect nesting and brood-rearing areas for birds.

Various features and criteria for the production pads proposed under Alternative A – FFD will need be similar to those incorporated into the pad designs under Alternative A (CD-3 through CD-7) to eliminate or minimize the potential for impacts to and from surface waters. These criteria are more stringent for those facilities on the Delta (that is, 200-year flood for CD-3 and CD-4) than those on the Coastal Plain (a 50-year flood for CD-5, CD-6 and CD-7), which are not close to creeks or lakes. Future monitoring of water level conditions and flow paths in potential FFD pad locations will be needed to ascertain the potential risks to each production pad location and to downstream waters.

IMPACTS TO ESTUARIES AND NEARSHORE ENVIRONMENT

Because the locations of production pads, roads, and pipelines for Alternative A are not near the coast, no direct impacts to the physical conditions or processes within the estuarine and nearshore environments would be expected. Storm surges and wave action, however, could affect the operation of some of the proposed facilities (i.e., CD-3 pad). This is discussed in the previous section.

The CD-4 pad and short sections of the roads will, however, be situated close to delta channel shorelines, so it is important to characterize the potential for channel migration and channel bank erosion. Detailed analyses have been done at a few locations (at the Nigliq Bridge crossing), and these analyses suggest bank shoreline erosion rates are highly variable from year to year. Nearshore monitoring should be conducted in critical areas where pad sites and roads are relatively close to channel shorelines. An increase in channel shoreline erosion rates would hasten the need to conduct monitoring studies and programs prior to implementing erosion abatement measures.

Except for one HP in the Kalikpik–Kogru Rivers Facility Group (HP-22), all the production pads and access roads under Alternative A – FFD would be located at least 3 miles from the coast. Because the pad, road, and pipeline locations would not be near the coast, direct impacts to the physical conditions or processes within the estuarine and nearshore environments are not likely. However, due to the increase in road- and stream-crossings, increased erosion and downstream sedimentation is likely. Although prudent and effective designs can mitigate much of the potential for these effects, it is still likely that due to the sheer number of crossings, some impacts will occur. The result would be an increase in sedimentation to the delta and to Harrison Bay which could impact sediment transport processes and estuarine and nearshore habitat. The site of HP-22 appears to be on relatively high ground between two thaw-lakes approximately 1,500 feet from an actively eroding coastline. This indicates that appropriate monitoring of coastal processes is warranted to locate and design for any potential access road, pipeline, or production pad in this area. Nearshore monitoring could also be conducted at other pad sites that are relatively close to the coast or channel shorelines (CD-3, HP_-3, HP-5, HP-12, HP-13 and HP-14). An increase in coastal and channel shoreline erosion rates would hasten the need to conduct comprehensive monitoring studies and programs.

IMPACTS ASSOCIATED WITH ICE CONDITIONS

The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and their hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a “worse-case” location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations will be exceeded by floodwater even when ice-jamming conditions are considered.

Although these conclusions are reasonable and intuitive, the ice jam modeling that supports this conclusion was unable to simulate conditions similar to those in 2004 because of the limitations described above. For example, the size, orientation, and condition (bottomfast versus shorefast and floating) of the modeled ice jam did not result in a significant large re-direction of flow, which was observed to occur in 2004. The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta, but because of the sensitivity in underestimating impacts these model results should be viewed cautiously due to the difficulty in accurately simulating ice jams.

For both Alternative A and Alternative A – FFD, the likelihood of failure of pipeline, road, and facility structures associated with ice conditions is possible but minimized considerably by conservative designs. Monitoring of such structures during development of APF-1 continues to provide input to mitigation design features. The continued incorporation of design improvements based on this monitoring suggests that potential impacts from ice conditions are not likely to increase from current conditions and practices.

ALTERNATIVE A – POTENTIAL MONITORING PLANS AND MITIGATION MEASURES (CPAI AND FFD) FOR WATER RESOURCES

SUBSURFACE WATERS

- The USEPA has not determined whether the aquifers in the vicinity of the production pad wells meet the other elements of the underground sources of drinking water (USDW) definition. For each proposed disposal well, the USEPA (the primary agency responsible for granting an aquifer exception) will make the appropriate decision, in consultation with the AOGCC.

SURFACE WATER – LAKES

- Prior to lake withdrawals, lake monitoring studies are recommended for each lake where withdrawals are proposed to evaluate the possibility of affecting lake habitat and recharge potential, and to verify the prediction that the lakes are fully recharged annually during break-up.

- It is also recommended that water monitoring programs should be further developed for representative areas within the Plan area where withdrawals are anticipated. These programs would measure lake water levels over time, provide estimates of recharge and surplus volumes, and document any observed changes of water quality parameters over time as an assessment of impacts on lake habitats. Data from such monitoring and other future studies would be integrated with assessments of impacts to lake habitat to determine if modifications of permit stipulations are necessary (e.g., changes in water withdrawal limitations, additional water quality monitoring, or changes to existing lake observation programs, etc.).

SURFACE WATER – FLOW

- Approaches to both the Nigliq Channel and Ublutuoch River bridges and the road from the existing facility to CD-4 will need to provide for natural water flow to adhere to CWA Section 404(b)(1) guidelines and assure that cross flow maintains the natural hydrologic regime. The bridge approach and road design for the road from CD-2 to CD-5 must demonstrate that cross flow will be adequate to prevent raising the water level on the upstream side of structures by more than 6 inches, compared to that for downstream for more than 1 week after peak discharge. The need for a similar requirement for the CD-4 Road may not be necessary because of the nature of flow (parallel to the road as opposed to perpendicular to the road). The bridge approach and road designs must remain sound and not be washed out at all flow levels. Cross flow along the bridge approaches and roads would be allowed using culvert batteries or box culverts.

- Limiting road, production pad and bridge construction to the winter season would minimize potential impacts to surface waters.

- After construction, continued monitoring of bridges, pipeline VSMs, road embankments, and culvert crossings is recommended to develop adaptive mitigation measures that protect against potential structural failures and improve on subsequent designs. This monitoring should also incorporate breakup observations to decrease the potential impacts from ice conditions.

- Streambank erosion monitoring and nearshore coastal erosion monitoring is recommended for all production pad sites that are relatively close to the coast or channel shorelines (CD-3, CD-4, HP-3, HP-5, HP-12, HP-13 and HP-14). Further, similar monitoring programs including geotechnical investigations are recommended for the proposed bridge/culverts at all stream crossings. An increase in coastal and channel shoreline erosion rates would also hasten the need to conduct even more comprehensive monitoring studies prior to implementing erosion abatement measures. Nearshore monitoring is recommended for critical areas where pad sites and roads are relatively close to channel shorelines.

- It is recommended that the storm surge analyses be updated using plausible weather and open-water sea conditions that represent conditions that will prevail over the next 20-30 years or for the projected lifespan of the project. Based on recent studies, climate change processes are likely to yield smaller ice packs and more open water, resultant bigger rainfall events and higher magnitude storm surges

- Continued data gathering (including some additional programs that are not currently being undertaken) is recommended and includes: continuous monitoring of water-surface elevations and streamflow throughout break-up, summer and freeze-up periods for all affected streams. This continued monitoring would provide data in support of models and analyses and future development in the region. In particular, it is recommended for those streams with important bridge crossings (the proposed 120-foot bridge on the Ublutuoch River, the 1,200-foot bridge on the Nigliq Channel, and the 80-foot bridge on the paleochannel) a comprehensive data set would improve the characterization of low-water conditions important for addressing navigation and fish habitat concerns, and improve estimates of flood frequency, flooding processes, channel migration processes, and scour potential.

- Future monitoring of water-level conditions and flow paths in the drained lake basin is needed to minimize the potential risks to the CD-7 pad and downstream waters.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR WATER RESOURCES

Stipulations 5 (a), (b), (c), and (d) of the Northeast National Petroleum Reserve-Alaska IAP/EIS protect water quality by preventing the discharge of wastewater or other discharges into water bodies or wetlands. Stipulations 14, 15, and 16 reduce the likelihood of a fuel spill in a water body by having distance and quantity restrictions. Stipulation 22 protects the banks of waterways by prohibiting alteration of the banks and protecting riparian vegetation. Stipulations 39 and 41 have distance from water body prohibitions for the placement of facilities while 42 and 43 help prevent affecting stream flow and preventing erosion. This EIS has not identified any additional mitigation measures (see Alternative A – Potential monitoring Plans and Mitigation Measures for Water Resources above) which would be effective in minimizing impacts related to erosion, sedimintation, impediment of flows, and lake and stream hydrology .

4A.2.2.2 Surface Water Quality

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SURFACE WATER QUALITY

CONSTRUCTION PERIOD

NPDES Discharge

Temporary camps could be used at each production pad during construction and drilling operations. Most sewage and all solid waste would be transported to CD-1 for disposal with systems in place at CD-1. However, discharges of treated domestic wastewater to tundra could occur in accordance with the NPDES permit (AKG-33-0000) requirements. Specific limitations in the draft NPDES permit include: 6.5<pH<8.5; no film, sheen or discoloration on receiving water surface; no floating solids, foams, or garbage; no discharge of kitchen oils; and quantitative limitations on flow, biochemical oxygen demand, total suspended solids, fecal coliform, and total residual chlorine. Discharges to tundra wetlands require development of a BMP plan to address prevention of chlorine burn and excessive nutrients and/or sediment loading of the tundra. The applicant’s Notice of Intent states that discharges would be to tundra wetlands and not open waters, so USEPA does not plan to authorized NPDES discharges to rivers. These conditions support the conclusion that no measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permits would be expected.

Table 4A.2.2-12 shows the USEPA’s monitoring requirements for the NPDES permit effluent. Monitoring would be conducted for the parameters indicated in the table by measuring, observing, or sampling effluent and recording data. Results would be reported to the USEPA. Detailed records of all monitoring aspects would be kept.

The accidental release of sewage from a spill, while not authorized under an NPDES permit, is another source of potential impacts to surface water quality. Sewage spills are usually small and would typically occur on gravel pads or roads during pumping or transferring, or result from frozen lines. During the winter, clean up would be relatively easy because the fluid freezes rapidly in the low ambient temperatures. In the summer, sewage would soak into the pad and the only response would be to spread lime over the area for disinfection. A BMP plan would be required and should address how to avoid these types of spills. However, the upset provisions of a permit would apply to a spill to Waters of the United States.

TABLE 4A.2.2-12 MONITORING REQUIREMENTS

Parameter	Sample Location	Sampling Frequency[1]		Type of Sample
		Lower Flows[2]	Higher Flows[3]	
Total Flow	Effluent	Daily	Daily	Estimate or measured
BOD_5	Effluent	Monthly	Weekly	Grab or composite
TSS	Effluent	Monthly	Weekly	Grab or composite
pH	Effluent	Monthly	Weekly	Grab
Fecal Coliform	Effluent	Monthly	2/Month	Grab
Dissolved Oxygen	Effluent	Weekly	Weekly	Grab
TRC	Effluent	Weekly	3/Week	Grab
Floating Solids	Effluent	Daily		Observation
Foam	Effluent	Daily		Observation
Garbage	Effluent	Daily		Observation
Oily Sheen	Effluent	Daily		Observation

Notes:
[1] At least one sample shall be taken per discharge event.
[2] Up to and including 10,000 gpd
[3] Over 10,000 gpd

Water Withdrawal from Lakes

Fresh water would be withdrawn from lakes within the Plan Area for three primary uses: construction of ice roads and pads during the winter construction season and for pipeline maintenance; production drilling; and potable water at the camp facilities (CD-1) and temporary construction and drilling camps. Water would also be used for dust control on roads. Ice road construction would require approximately 1 million gallons of water for each mile of road built. Estimated miles of ice roads required each year during construction would vary from a minimum of 16 to a maximum of 67 (see Table 2.4.1-2). The drilling program would require 38,000 gpd of water to support drill rig and mud plant operations at each production pad location (CPAI 2003). The drilling mud would be mixed at CD-1, so water would be withdrawn from lakes near CD-1, not at the individual production pads. In addition, approximately 5,000 gpd of potable water would be used by the rig camp operations. Water withdrawal from lakes would gradually lower the water levels throughout each winter and during the drilling in the summer months each year. However, naturally occurring recharge in the spring would be expected to fully replace—and under certain conditions even exceed—the withdrawn water volumes in the lakes (Michael Baker Jr. Inc. 2002). Permit conditions for water withdrawal would govern which lakes could be used, the acceptable withdrawal quantities and the monitoring that must be performed.

Lakes in the Plan Area that would be used for water withdrawal could be tapped lakes or perched lakes that are recharged by periodic flood events or by snowmelt and runoff each spring (Michael Baker Jr. Inc. 2002). Water withdrawal in the winter would potentially alter lake water chemistry temporarily by oxygen depletion and ion concentration (see Alkalinity and pH and Oxygen sections) (URS Corporation 2001). However, data has shown that at the given levels of use, changes to water chemistry occurred but were minor. In fact, dissolved oxygen concentrations at pumped lakes with a circulator employed to prevent pump intake and hole re-freeze appeared to decrease at a slower rate over the winter than in reference lakes. Permit conditions governing water withdrawals would be written to prevent any degradation of water quality during the winter months that would compromise fish habitats. Because multiple permitted lakes are available as supplemental water supply, degradation at individual locations could be mitigated through use of alternate sources. Oxygen depletion and ion concentration effects would be expected to be seasonal and would cease with the onset of spring break-up and recharge.

Erosion and Sedimentation

Alterations in surface drainage patterns from construction of roads, pads, and airstrips could affect both water levels and water quality in adjacent wetlands and streams. Culverts, berms, and undersized bridges tend to concentrate flows that would otherwise disperse over a wider area. Concentrated flows are more likely to erode ice-rich soils and, consequently, could increase turbidity and sediment deposition within small drainage areas adjacent to roads, bridges, and other facilities. Adequate sizing of culverts and bridges for passage would reduce the likelihood of erosion.

Potability

Surface water bodies in the Plan Area do not meet potable water standards without treatment. Any potable water treatment or domestic wastewater treatment system must undergo the ADEC's plan review and approval. Domestic (sewage and gray water) effluent discharge would be allowed, but only in compliance with conditions specified in the NPDES permit. Discharges could occur at temporary camps at each drill site. No discharge of sewage directly to water bodies in the Plan Area by industry would occur. Therefore, no increase in fecal coliform counts over the naturally occurring concentrations would be anticipated.

Turbidity

Where gravel fill is placed in wet areas to construct a road, pad, or airstrip, the receiving waters could temporarily have higher suspended solids concentrations and greater turbidity. Because gravel fill construction would take place in winter, and most water bodies would be frozen, impacts on water quality would be limited to the entrainment of fine-grained fill material in runoff from the facilities during the spring thaw and/or during rainfall events during the summer following construction. However, impacts to surface waters are still possible at river and lake crossings that do not freeze to the bottom. For example, at Lake 9323 the water depth is 8 feet at the culvert crossing, indicating that it will likely not freeze to the bottom. Even though construction of the CD-4 road-crossing of this lake would be conducted during the winter, there is a potential to impact water quality within the lake. Similarly, construction of the Nigliq and Ublutuoch River Bridges would be conducted over two winters, including the installation of numerous piers at the Nigliq Crossing; thus, water quality in the channels could be impacted during winter construction.

The primary effect on water quality from construction and placement of gravel structures is related to upslope impoundment and thermokarst erosion (Walker et al. 1987). Thermokarst erosion, partially caused by tundra disturbance and partly by the thermal effect of dust blown off the gravel onto the tundra, can result in water features with high turbidity and suspended-sediment concentrations. Thermokarst erosion could cause the state turbidity standard to be exceeded temporarily within and downflow of the thermokarst features. In flat, thaw-lake plains on the North Slope, gravel construction could result in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel, or approximately 482 acres for the development assumptions made for Alternative A.

Dust fallout from vehicle traffic could temporarily increase turbidity within ponds and lakes adjacent to roads and construction areas in the Plan Area. Algae productivity also could increase from nutrients entering the water with the dust. Depending on the average size of the airborne particles, prevailing wind direction, and wind speed, dust fallout would typically occur within 330 feet of the activity (USACE 1980). However, because construction and most vehicular traffic associated with the applicant's proposed action would occur during winter, any adverse impacts on water quality from dust should be minimal. If dust control becomes a problem and a chemical binder is required, ADEC approval may be required.

No impact to water quality from winter water extraction from lakes would be expected. Turbidity increased similarly in both pumped and unpumped lakes in 2002 monitoring (Michael Baker Jr. Inc. 2002).

Alkalinity and pH

As surface waters freeze, salts are excluded from the forming ice into the underlying water, increasing salinity. In coastal tundra waters, the alkalinity is associated with the salt content, and increases and decreases in alkalinity parallel those of salinity. Pumping water from a lake in the winter would remove the relatively more saline and more alkaline water from under the lake ice. During snowmelt in the spring, less saline, less alkaline runoff water would replace the removed waters. In lakes less than 6 feet-deep, which freeze to the bottom, the salts normally would be frozen out of the entire water column and extruded into the sediment thaw bulb underlying the lake. These salts then slowly and partially leach back into the water column the following summer. For such lakes, the early summer condition would be relatively low salinity, low alkalinity water, regardless of whether or not water was removed for ice road construction. Based on observed lake pH, these lakes are weakly, but still apparently adequately, buffered against acid snowmelt.

In lakes greater than 6 feet-deep, the salts and alkalinity excluded from ice formation normally would remain in the unfrozen bottom water. These lakes start the summer with more saline, relatively strongly buffered (against acid snowmelt) waters underneath the melting ice. Winter removal of more saline water underneath the ice would result in less saline, less buffered lake waters in early summer, following winter water extraction. Thus, following winter extraction of water, their early summer chemistry would be more similar to that of lakes less than 6 feet deep. However, lake monitoring studies performed in conjunction with water withdrawal for National Petroleum Reserve-Alaska exploration activities showed no measurable difference in salt content for water in pumped versus reference lakes (URS Corporation 2001). Measurements of pH values for pumped and unpumped lakes in 2002 increased by 1.43 and 1.52 units, respectively (Michael Baker Jr. Inc. 2002). Values of pH similarly increased in previous investigations (URS Corporation 2001). No measurements of alkalinity were reported in recent lake studies in the Plan Area.

Another way that ice road construction could affect water quality would be through changes in water chemistry along the roadbed during and after meltout. As described above, the water withdrawn from lakes to construct the roadway is relatively more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice before it melts during snowmelt, increasing initial salt content of the meltwater. This effect could potentially occur during initial snowmelt, but the effect on water quality should be localized, most likely expressed as a slight buffering of pH during initial snowmelt.

Use of water for construction, drilling, and domestic (crew) needs could affect water quality, as discussed for ice road construction. Effects during construction and drilling on water quality from any of these mechanisms would be short-term, lasting generally one season.

Annual ice road construction could cover between 78 and 325 acres during each year of construction under Alternative A – CPAI Development Plan (based on estimated annual miles of ice roads constructed shown in Table 2.4.1-2). This ice road construction, as well as drilling needs, would require winter extraction of water that would affect up to 200 ac-ft of nearby intermediate-depth (6 feet) and deeper lakes every year. The affected areas of the ice road footprint could change each year because typically the ice roads would be shifted over one road width within the Plan Area to avoid continued compaction of vegetation. Temporary upslope impoundment of snowmelt waters could cover areas parallel to ice road construction for a few days each spring, but without measurable effect on water quality. Due to the seasonal fluctuations in surface water quality, treatment of this water for drinking water purposes is challenging.

Oxygen

Ice road construction over lakes deep enough not to freeze to the bottom could affect dissolved oxygen concentrations. Many of these lakes are just a foot to a few feet deeper than the minimum 6-foot depth necessary to maintain some unfrozen bottom water in winter. An ice road across such an intermediate-depth lake could freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. With mixing thus reduced, isolated water pools with low oxygen could result. Dissolved oxygen concentrations could be reduced below the 5 ppm dissolved oxygen standard needed to protect resident fish (ADEC 2003b). However, it is rare that industry would build an ice road across a lake.

Withdrawal of water for ice road construction is another potential source of impact to dissolved oxygen concentrations. However, in 2002, dissolved oxygen levels in pumped lakes were nearly three times the average concentration of the reference lakes. Higher levels of oxygenation in pumped lakes could have been a result of circulating water used to keep the hole open in the ice (Michael Baker Jr. Inc. 2002).

Estuarine Waters and Water Quality

No construction, disturbance, or discharges would occur in estuarine areas under Alternative A – CPAI Development Plan. Because almost all of the yearly flow of rivers on the North Slope occurs in the short spring and summer periods, there is a great seasonal difference for suspended sediment flow regimes. During high flow periods, streams often carry highly turbid water toward the ocean and deposit sediments in low-velocity locations within the floodplain, such as deltas or overbank areas. The naturally high turbidity of estuarine waters during high flow levels would show no measurable increase in suspended sediments attributable to activities associated with the applicant’s proposed action. During times of lower flow levels, turbidity of entering rivers would be lower, but no project-related increases in river turbidity would be expected. The project-related actions that would result in increased suspended sediment inland to rivers, and thereafter to estuarine water, from erosion or sedimentation would occur only during the spring and summer when the water flow is high, and the increase in estuarine water turbidity would not be measurable.

Marine Water Quality

No measurable degradation of marine water quality would result from construction activities related to the applicant’s proposed action.

OPERATION PERIOD

Impacts to surface water quality from potential spills are not presented here, but rather in Section 4.3. Water quality impacts potentially resulting from construction, drilling, operations, and abandonment activities are described in this section. Potentially affected water resources include the Colville River and its distributaries, other rivers and streams in the Plan Area (for example, Fish Creek, Judy Creek, Ublutuoch River), Harrison Bay, and lakes and ponds. The primary beneficial uses for these unimpaired, high-quality surface waters are growth and propagation of fish and wildlife.

NPDES Discharges

Discharges of treated wastewater could occur to tundra in accordance with NPDES permit requirements. For the applicant’s proposed action, very little wastewater would be generated at the five production pads after construction and drilling are complete because all personnel would be lodged and based at the existing camp at CD-1. Temporary camps could be used at each production pad during drilling operations. All sewage and solid waste would be transported to CD-1 for disposal with the systems in place at CD-1. No measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permit would be expected. A condition of the NPDES permit for surface discharge of this treated wastewater is to obtain a mixing zone authorization from the ADEC.

Water Withdrawal from Lakes

Fresh water would continued to be withdrawn from lakes within the Plan Area during the operation period when ice roads are required to access production pads not connected by gravel roads. However, the miles of ice roads to be constructed during the operation period, and thus, the volume of water required, is estimated to be about one-quarter of that built during the construction period (see Table 2.4.1-2). Permit conditions for water withdrawal would govern which lakes could be used, the quantities that could be withdrawn, and the monitoring that must be performed. Because multiple permitted lakes are available as supplemental water supply, degradation at individual locations could be mitigated through use of alternate sources. Any oxygen depletion and ion concentration effects would be expected to disappear after spring recharge and ice melting.

Erosion and Sedimentation

Continued alterations in surface drainage patterns after construction of roads, pads, and airstrips could affect both water levels and water quality in adjacent wetlands and streams. However, installing adequate numbers of sufficiently-sized culverts will reduce the likelihood of erosion damage.

Potability

No discharge of sewage directly to water bodies in the Plan Area by industry would occur during operations. Therefore, no increase in fecal coliform counts over the naturally occurring concentrations is anticipated.

Turbidity

Increased turbidity of water bodies in the Plan Area would result from dust fallout, flooding, erosion, or bank failure. Once construction is completed, the gravel roads between pads or connecting pads to airstrips and the gravel pads would be the only, but potentially large, dust source from the proposed action. Dust fallout from vehicle traffic could increase turbidity within ponds, lakes, creeks, streams, and rivers adjacent to roads and construction areas in the Plan Area. As described in Section 4A.2.2.1, hydrologic changes resulting from project features (i.e., roads, pads, bridges) could increase the chance of flooding, erosion, and bank or gravel road failure. These events would result in temporary increases in turbidity in water bodies, but it is not possible to provide quantitative estimates.

Alkalinity, pH, Oxygen

Water withdrawal for construction of ice roads and for operations would continue to have short-term, (one season) impacts on alkalinity, pH, or oxygen content of water in the Plan Area.

Estuarine Waters and Water Quality

Water quality impacts described above for fresh water would generally be the same for estuarine waters. However, increased salinity and lower turbidity of estuarine waters compared to inland lakes and rivers would result in some differences in expected impacts. No construction, disturbance, or discharges would occur in estuarine areas of the Colville River Delta under Alternative A – CPAI Development Plan or under Alternative A – FFD. However, accidental spills reaching rivers and estuarine waters and activities causing increased sediment in rivers would be two possible sources of impacts to estuarine water quality. Oil spill impacts are described in Section 4.3, and spills of miscellaneous fluids would not be expected to be of sufficient size to reach estuarine waters. A saltwater spill from a pipeline flowing to an individual production pad would be the most likely scenario for an accidental release reaching estuarine waters. However, the higher salinity (approaching marine water salinity) of these waters in comparison to inland water bodies would prevent measurement of any change in salinity in estuarine water. The most detrimental impact to estuarine water quality from a seawater spill would be from the biocides or other chemicals added during treatment before flow to the production pads.

Because almost all of the yearly flow of rivers on the North Slope occurs in the short spring, summer, and fall periods, there is a great seasonal difference for suspended sediment flow regimes. During high flow periods, streams often carry highly turbid water toward the ocean and deposit sediments in low-velocity locations within the floodplain, such as deltas or overbank areas. The naturally high turbidity of estuarine waters during high flow levels would show no measurable increase in suspended sediments attributable to activities associated with the applicant’s proposed action. During times of lower flow levels, turbidity of entering rivers would be lower, but no project-related increases in river turbidity should occur. Actions that would result in increased suspended sediment inland to rivers, and thereafter to estuarine water, from erosion or sedimentation would only occur during spring and summer when the water flow and turbidity are naturally high. Increases to estuarine water turbidity during this period would be immeasurable when compared to naturally occurring concentrations.

Marine Water Quality

With the exception of a potential oil spill transported by river flow to Harrison Bay and the Beaufort Sea, no measurable degradation of marine water quality would result from Alternative A – CPAI Development Plan or Alternative A – FFD. Impacts to marine water quality from potential oil spills are presented in Section 4.3.

ABANDONMENT AND REHABILITATION

Water demand during abandonment operations could impact lakes in ways similar to that described for water withdrawal during construction. Also, like construction, abandonment activities (removal of gravel pads and bridges) could cause a short-term and localized increase in sedimentation and turbidity and change alkalinity and oxygen content. Leaving roads and production pads in place, especially without maintenance or stabilization through successful revegetation, could increase sedimentation and turbidity through erosion and upslope impoundment.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SURFACE WATER QUALITY

Impacts to water quality under Alternative A – FFD would be the same as those described for Alternative A, except for those described in the following sections.

CONSTRUCTION AND OPERATION PERIODS

Impacts during construction and operation periods would be similar and are discussed together.

NPDES Discharges

Under Alternative A – FFD, all sewage and solid waste would be disposed of at HPF-1 and HPF-2 by injection to the subsurface in a manner analogous to that used at CD-1. Wastewater discharges to tundra at individual pads could be performed under the NPDES permit (AKG-33-0000). The permit covers gravel pit dewatering, stormwater, and domestic wastewater from temporary camps. The pollutant content of the permitted discharges would be regulated through monitoring of permit conditions as issued by the USEPA. Monitoring is required as a condition of the permit to ensure that discharges do not exceed water quality standards, are not toxic to organisms in receiving waters, do not degrade water quality, and do not pose a threat to human health. Thus, no measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permit would be expected.

Water Withdrawal from Lakes

Fresh water would be withdrawn from lakes within the Plan Area for three different uses:

- Construction of ice roads and pads during the winter season
- Production drilling and processing operations
- Potable water at the project camp facilities (CD-1, HPF-1, and HPF-2) and temporary construction and drilling camps

Ice road construction would require approximately 1 million gallons of water for each mile of road built. Based on the estimated miles of ice roads shown in Table 2.4.1-9, a maximum of 160 ac-ft of water would be withdrawn from lakes each year for ice road construction. The drilling program would require 38,000 gpd of water to support drill rig and mud plant operations at each production pad location (CPAI 2003). The drilling mud would be mixed at CD-1, so water would be withdrawn from lakes near CD-1, not at the individual production pads. Drilling mud would also be mixed at HPF-1 and HPF-2. In addition, approximately 5,000 gpd of potable water would be used by the rig camp operations. Water withdrawal from lakes would gradually lower water levels throughout each winter and during the drilling in the summer months each year. However, naturally occurring recharge in the spring would be expected to fully replace, and under certain conditions even exceed, the withdrawn water volumes in the lakes (Michael Baker Jr. Inc. 2002). Permit conditions for water withdrawal would govern which lakes could be used, the quantities that could be withdrawn, and the monitoring that must be performed.

Turbidity

Where gravel fill is used to construct roads, production pads, or airstrips in wet areas, the receiving waters could temporarily have higher suspended solids concentrations and more turbidity. However, since gravel fill construction would take place in winter, water quality impacts would be limited to the entrainment of fine-grained fill material in runoff from the facilities during the spring thaw and/or during precipitation events during the summer following construction. Stormwater planning/permitting is covered under the NPDES permit.

The primary effect on water quality from construction and placement of gravel structures relates to upslope impoundment and thermokarst erosion (Walker et al. 1987). Thermokarst erosion, partially caused by tundra disturbance and partly by the thermal effect of dust blown off the gravel onto the tundra, can result in water features with high turbidity and suspended-sediment concentrations. Thermokarst erosion could cause the state turbidity standard to be exceeded within and downflow of thermokarst features. In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel, or 2,524 acres under Alternative A – FFD.

Alkalinity and pH

Annual ice road construction could cover between 44 and 252 acres (9 to 52 miles) each year, on average, during construction activities (based on estimated miles of ice roads shown in Table 2.4.1-9). Ice road construction could affect water quality through changes in water chemistry along the roadbed during and after meltout. As described above, the water withdrawn from lakes to construct the roadway is relatively more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice before it melts during snowmelt, increasing initial salt content of the meltwater. This effect could potentially occur during initial snowmelt, but the effect on water quality should be localized, most likely expressed as a slight buffering of pH during initial snowmelt.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SURFACE WATER QUALITY

Potential surface water quality impacts under Alternative A – CPAI Development Plan generally fall into three general source categories:

- Accidental release of fuels and other substances, including oil spills, which could occur during both the construction and operation periods
- Reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations
- Increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which would could occur during both the construction and operation periods.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SURFACE WATER QUALITY

No additional measures have been identified to mitigate impacts to water quality under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SURFACE WATER QUALITY

Stipulations 5(a), (b), (c) and (d) of the Northeast National Petroleum Reserve-Alaska IAP/EIS protect water quality by preventing the discharge of wastewater or other discharges into water bodies or wetlands. Stipulations 14, 15, and 16 reduce the likelihood of a fuel spill in a water body by having distance and quantity restrictions. Stipulation 22 protects the banks of waterways by prohibiting alteration of the banks and protecting riparian vegetation. Stipulations 39 and 41 have distance from water body prohibitions for the placement of facilities while 42 and 43 help prevent affecting stream flow and preventing erosion. This EIS has not identified any additional mitigation measures.

4A.2.3 Atmospheric Environment

Air pollutants generated in the Plan Area will consist of emissions from mobile, stationary, portable and fugitive sources from activities occurring in the construction, drilling, and operational phases. Mobile sources would include construction equipment, such as graders and haul trucks, and equipment from aircraft flights and vehicular traffic, such as passenger vehicles and light-duty trucks. Stationary sources would include fossil fuel combustion equipment, such as power generation turbines and backup emergency generator engines, and production and drill site heaters. Portable sources include drill rig engines and associated boilers, and heaters used during drilling operations. Fugitive sources are typically fugitive dust and entrainment from dirt and gravel road use and heavy construction activities which are generally limited to the winter period, with the exception of CD-4, which will be constructed in the summer. However, the arctic climate naturally limits fugitive dust because the ground is generally snow and ice covered, therefore making it an insignificant source in the Plan Area.

Alternative A – CPAI Development Plan would create new sources of air emissions within the Plan Area. A gas-fired drill site heater will be included at each of the five production pads (CD-3 through CD-7), and diesel-fired emergency generators will be installed at CD-3 and CD-6, assuming that all sites but CD-3 will be road-accessible. If they are not road-accessible, diesel-fired emergency generators will be added to those sites, resulting in additional emissions, depending on generator capacity.

Alternative A also includes a component of the existing APF-1's upgrade called the ACX. This three-stage project is designed to increase processing capacity of APF-1. It includes ACX-1 and ACX-2 that are related to handling existing production (i.e. produced water volumes and oil train and water injection) and ACX-3 for production from the proposed development. ACX-3 will include a gas-fired turbine (Frame 5) and a gas-fired process heater located at the existing APF-1.

Alternative A – FFD would add seven additional production pads to the Colville River Delta, along with CD-3 and CD-4, each requiring a gas-fired drill site heater. Emergency generators for each of the seven pads are a worst-case scenario, and might not be required.

Alternative A – FFD would add 11 new pads in the Fish–Judy Creeks Facility Group, along with corresponding drill site heaters and emergency generators. This group also would include the HPF-1, and would be the largest source of criteria pollutant emissions under Alternative A – FFD. For the purpose of this discussion, it is assumed that the processing equipment at HPF-1 would be similar to the existing APF-1, with a similar emissions inventory.

The Kalikpik–Kogru Rivers Facility Group would include four new production pads and the hypothetical processing facility HPF-2.

A summary of proposed emissions is presented in Table 4A.2.3-1. An inventory of the project sources and their respective air emissions is presented in Tables 4A.2.3-2 through 4A.2.3-4 in tabular format according to the construction, drilling, and operational phases. The construction phase emissions inventory shows potential construction equipment, size (by horsepower rating), and the typical criteria pollutant emissions in pounds per hour. Construction emissions would vary according to the operational hours and loading of each piece of equipment during the construction phase.

The drilling phase emissions inventory is presented in tons per year of actual emissions. Only the criteria pollutants NO_x, SO_2,Carbon Monoxide (CO), and PM_{10} are listed, as the project would be a minor source of VOCs. The annual emissions shown on Table 4A.2.3-3 are based on a rolling report of actual hours as required by the current APF-1 operating permit.

Table 4A.2.3-4 is the operational phase emissions inventory. This table delineates the operational sources under Alternative A – CPAI Development Plan and Alternative A – FFD, by facility groups. Estimated operating hours and emissions are based upon current APF-1 operating permit conditions.

A map of the Alternative A layout is shown in Figure 2.4.1.1-1. A map of Alternative A – FFD is shown in Figure 2.4.1.2-1.

TABLE 4A.2.3-1 ALTERNATIVE A – CPAI DEVELOPMENT PLAN AND FFD SCENARIO EMISSIONS SUMMARY

Proposed Project Phase	Facility Group	Maximum Emissions (tons/year)			
		NO_x	SO_2	CO	PM_{10}
Construction	NA	17.7	1.29	4.21	1.29
Drilling	NA	26.66	3.02	5.85	1.34
Operation	NA	742.1	9.72	212.4	7.3
Operation – FFD Scenario	Colville River Delta	339.1	34.7	111.9	10.5
	Fish–Judy Creeks	3,152.8	159.7	559.5	59.9
	Kalikpik–Kogru Rivers	2332.1	168.2	376.9	47.9

TABLE 4A.2.3-2 ALTERNATIVE A – CPAI DEVELOPMENT PLAN CONSTRUCTION PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Equipment	Fuel Type	Rating (hp)	Estimated Emissions									
			NO_x		SO_2		CO		PM_{10}		VOC	
			lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr
Dump Truck[a]	Diesel	235	7.3	2.0	0.5	0.14	1.6	0.44	0.5	0.14	0.6	0.16
Dumper, 4-ton[a]	Diesel	200	6.2	1.7	0.4	0.11	1.3	0.35	0.4	0.11	0.5	0.14
Flat Bed/Tractor Trucks[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Fork Lifts 3-ton[a]	Diesel	75	2.3	0.6	0.2	0.05	0.5	0.14	0.2	0.05	0.2	0.05
Front Loader[a]	Diesel	140	4.3	1.2	0.3	0.08	0.9	0.25	0.3	0.08	0.3	0.08
Grader[b]	Diesel	150	3.8	1.0	0.5	0.14	1.3	0.35	0.4	0.11	0.3	0.08
Mobile Crane, 30-ton[a]	Diesel	100	3.1	0.9	0.2	0.05	0.7	0.19	0.2	0.05	0.2	0.05
Mobile Crane, 60-ton[a]	Diesel	200	6.2	1.7	0.4	0.11	1.3	0.35	0.4	0.11	0.5	0.14
Mobile Crane, 80-ton[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Shovel[a]	Diesel	100	3.1	0.8	0.2	0.05	0.7	0.19	0.2	0.05	0.2	0.05
Transit Mixers[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Vibro Roller[b]	Diesel	42	0.9	0.3	0.0	0.0	0.3	0.08	0.1	0.03	0.1	0.03
Water Truck[b]	Diesel	200	4.2	1.2	0.5	0.14	1.8	0.49	0.3	0.08	0.2	0.05
TOTAL			**64.8**	**17.7**	**4.7**	**1.29**	**15.5**	**4.21**	**4.8**	**1.29**	**4.9**	**1.31**

Sources: USEPA and SCAQMD
Notes:
Construction emissions would vary according to the operational hours and loading of each piece of equipment during the construction phase. Air pollutant emissions shown were calculated based on emissions factors and the equipment rating. The emissions impact of the construction phase would be determined based upon loading and operational hours. The actual emissions may be lower than those presented above because most equipment operates at full-load only sporadically.
Portable heaters, light plants, and portable generators are not included in the summary.

[a] From USEPA Ap-42 Compilation of Air Pollutant Emissions Factors, Volume 2, mobile Sources

[b] From SCAQMD CEQA Air Quality Handbook, Table 9-8-C

TABLE 4A.2.3-3 ALTERNATIVE A – DRILLING PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Drilling Phase Source Inventory		Maximum Emissions (tons/year)			
Equipment	**Annual operating hrs**	**NO_x**	**PM_{10}**	**SO_2**	**CO**
Doyon Drilling Rig 19, Mud Plant and Bulk Plant[a]					
Caterpillar D398TA Power, 700 kW (4)[b]	820 total	9.33	0.06	0.42	2.04
Caterpillar D399TA Power, 976 kW (2)[b]	270 total	4.28	0.03	0.19	0.93
Caterpillar 3406 Rig Move Engine, 376 hp[c]	385	2.23	0.22	0.08	0.48
Caterpillar 3114 Pipe Shed Move Engine, 105 hp[c]	1390	2.25	0.06	0.08	0.49
Caterpillar D379TA Rig Camp Engines (2), 379 kW[c]	900 total	7.05	0.04	0.25	1.53
Caterpillar 3176 Cement pumps (2), 180 kW[c]	1,000 total	3.73	0.11	0.13	0.81
Superior Boilers (2), 3.4 MMBtu/hr[d]	8,380 total	0.50	0.12	0.48	0.12
Tioga Heater, 4.2 MMBtu/hr[d]	6,665	0.49	0.11	0.48	0.12
Tioga Heater, 3.5 MMBtu/hr[d]	8,000	0.49	0.11	0.48	0.12
Lister Heater, 4,0 MMBtu/hr[d]	7,000	0.49	0.11	0.48	0.12
Mud Plant Boiler, 1.3 MMBtu/hr[d]	8,760	0.20	0.12	0.19	0.05
Detroit 6063-GK35 Power, 300 kW[c]	500	3.10	0.23	0.11	0.67
Detroit 6063-GK35 Power, 160 kW[c]	500	1.66	0.12	0.06	0.36
Total Drilling Emissions		**26.66**	**1.34**	**3.02**	**5.85**

Sources: CPAI and USEPA

Notes:

[a] From actual emissions report as required by operating permit 489TVP01 for the Alpine Central Processing Facility (8/8/03).

[b] Emissions calculated utilizing USEPA AP-42 Emissions Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines (Table 3.4-1)

[c] Emissions were calculated utilizing USEPA AP-42 Emissions Factors for Uncontrolled Diesel Industrial Engines (Table 3.3-1)

[d] Emissions were calculated utilizing USEPA AP-42 Criteria Pollutant Emissions Factors for Fuel Oil Combustion (Table 1.3-1), except sulfur content by weight is calculated at 0.135 percent pursuant to operating permit conditions. This does not reflect low sulfur diesel requirements USEPA has mandated for 2006.

TABLE 4A.2.3-4 ALTERNATIVE A AND ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO OPERATIONAL PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Operational Phase Source Inventory – Proposed[a]						
Location	**Equipment** [b,c,d,e]	**Annual operating hrs**	**Maximum Emissions (tons/year)**			
			NO_x	**PM_{10}**	**SO_2**[f]	**CO**
CD-3	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
CD-4	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-5	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-6	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
	Power generator, gas-fired, 3.1 MW	8,760	472.7	0.8	0.07	64.5
CD-7	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
ACX3	Frame 5 turbine, 36,700 hp	8,760	147.3	0.8	1.05	94.0
ACX3	Heater, gas-fired 30 MMBtu/hr	8,760	13.1	1.0	*	9.2
TOTAL			**742.1**	**7.3**	**9.7**	**212.4**
Colville River Delta Facility Group						
CD-3	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
CD-4	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
7 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 7 additional pads	8,760 each	61.3	4.6	*	42.9
7 pads	Emergency generator, diesel-fired, 500 kW at each of 7 additional pads	4,000 each	227.7	3.9	30.4	49.7
TOTAL			**339.1**	**10.5**	**34.7**	**111.9**
Fish-Judy Creeks Facility Group						
CD-5	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-6	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
	Power generator, gas-fired, 3.1 MW	8,760	472.7	0.8	0.07	64.5
CD-7	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1

TABLE 4A.2.3-4 ALTERNATIVE A AND ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO OPERATIONAL PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY (CONT'D)

Fish-Judy Creeks Facility Group						
11 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 11 additional pads	8,760 each	96.4	7.2	*	67.5
11 pads	Emergency generator, diesel-fired, 500 kW at each of 11 additional pads	4000 each	357.8	6.2	4.3	78.1
APF-2	Additional Processing Facility[g]		2,167.0	43.0	151.0	324.0
TOTAL			**3,152.8**	**59.9**	**159.7**	**559.5**
Kalikpik-Kogru Rivers Facility Group						
4 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 4 additional pads	8,760 each	35.0	2.6	*	24.5
4 pads	Emergency generator, diesel-fired, 500 kW at each of 4 additional pads	4,000 each	130.1	2.3	17.4	28.4
APF-3	Additional Processing Facility[g]		2,167.0	43.0	151.0	324.0
TOTAL			**2,332.1**	**47.9**	**168.2**	**376.9**

Notes:

[a] Table assumes Alternative A, with all sites except CD-3 road-accessible (If not road-accessible, add an emergency generator at each site.)

[b] Drill site heater emissions are based upon current operating permit emission limits

[c] Emergency generator emissions are based upon USEPA AP-42 emissions factors for large stationary diesel and dual-fuel engines (Table 3.4-1 and Table 3.4-2)

[d] Power Generator emissions were calculated by using USEPA AP-42 emissions factors for Natural Gas-fired Reciprocating Engines (Table 3.2-2)

[e] Frame 5 turbine emissions at ACX-3 are based upon AP-42 emissions factors for stationary gas turbines (Table 3.1-1 and Table 3.1-2a), with added control of 68 percent, assuming 25 ppm NO_x and CO

[f] SO_2 permit emission limits are 200 parts per million by volume (ppmv) hydrogen sulfide (H_2S) in fuel gas; and a sulfur content of 0.135percent percent by weight in fuel oil

[g] Maximum emissions are based upon the current potential to emit of APF-1, which also includes 27 tpy of VOCs and 43 tpy of PM_{10}, for a total potential to emit of 2,712 tons per year (tpy)

4A.2.3.1 Climate and Meteorology

Impacts to climate and meteorology GHG emissions are unlikely to occur because the emissions are an infinitesimal contribution to the global GHG emissions budget. Further, it remains unclear what relationship GHG emissions have with changes in climate and meteorology except that observed and predicted changes are driven on a global scale and not a local or regional scale.

A discussion of GHG emissions and potential global warming as a result of GHG emissions and their impact on climate changes is presented in more detail in Section 3.2.3.1 and Section 4G.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON CLIMATE AND METEOROLOGY

CONSTRUCTION PERIOD

Construction activities would emit some greenhouse gases (GHG) over a short-term period from fossil fuel combustion of construction equipment (graders, bulldozers, trucks, etc.) and from aircraft flights transporting construction crew and materials.

OPERATION PERIOD

To a lesser extent and over a longer term, GHG emissions would occur from operation of natural gas-fired heaters and diesel backup generators, and from mobile sources such as vehicular traffic and aircraft takeoffs and landings.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities could have impacts similar to those of construction since it is anticipated that similar vehicles and other emission sources will be used. Because abandonment would not occur at a single location for any significant length of time, the impact of GHG emissions at any single location would be minor and short-term. Impacts would be less than construction if gravel fill is left in place, because there would be less use of the heavy vehicles and machinery that emit GHG. During and following abandonment, production facilities would no longer contribute to GHG emissions.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON CLIMATE AND METEOROLOGY

COLVILLE RIVER DELTA FACILITY GROUP

Some GHG emissions would result from activities at the additional seven production pads.

FISH–JUDY CREEKS FACILITY GROUP

GHG emissions would be somewhat greater than in the Colville River Facility Group because of operations of HPF-1, plus the two new production pads.

KALIKPIK–KOGRU RIVERS FACILITY GROUP

GHG emissions would be somewhat greater than in the Colville River Delta Facility Group because of operations of HPF-2, but somewhat less than GHG emissions from the Fish–Judy Creeks Facility Group because of a smaller number of new production pads.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON CLIMATE AND METEOROLOGY

GHG emissions would occur during construction and drilling activities from the operation of fossil fuel combustion equipment. Because construction does not occur at a single location for any significant length of time, the impact of these GHG emissions on the climate and meteorology at any single location would be minor and short-term. GHG emissions would also occur over a longer period from operations of Alternative A and Alternative A – FFD. However, GHG emissions generated from construction, drilling, and operational activities would have no effect upon the climate and meteorology of the region.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR CLIMATE AND METEOROLOGY

No mitigation measures have been identified. Cumulative impacts of GHG upon climate change are discussed in Section 4F.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR CLIMATE AND METEOROLOGY

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS nor were potential mitigation measures developed in this EIS.

4A.2.3.2 Air Quality

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON AIR QUALITY

CONSTRUCTION PERIOD

Emissions of criteria pollutants would occur during construction activities under Alternative A. Construction of the all-weather gravel roads, gravel airstrips, pipelines, and five production pads would have a temporary impact to ambient air quality in the immediate vicinity from emissions generated by construction equipment.

Emissions during construction activities would result from heavy equipment exhaust (earth movers, trucks, etc.), electric power generators, heaters, and other fuel-burning equipment. These emissions would consist primarily of NOx, SO_2, PM_{10}, paticle matter less than 2.5 microns, PM_{25}, and CO.

Respirable PM in the form of dust generated by mechanical disturbance of soil would be reduced because of frozen soil and snow cover during winter construction (only CD-4 would be constructed in the summer). Table 3.2.3-5 shows a single day's exceedance of the PM_{10} standard in 1999 (prior to the operation of APF-1). In this case, elevated particulate concentrations measured on that day were the result of wind-generated dust from the dried, exposed banks of the nearby Nigliq Channel.

Emissions would occur during equipment movement and site preparation activities. Because construction does not occur at a single location for any significant length of time, the impact of these emissions at any single location would be short-lived. Additionally, potential impacts of these emissions to regional air quality would be minor because these sources are transient and have relatively small emissions.

Air emissions would result from construction of gravel roads, primarily because of exhaust from diesel and gasoline-powered equipment. Particulate emissions would result from gravel and fugitive road dust. Fugitive dust emissions from primarily winter construction activity would be reduced due to frozen ground and snow cover. Equipment would consist of B-70 haul trucks, bulldozers, grading equipment, vibratory compactors, and tanker trucks (if road watering is required). Bulldozers, excavators/loaders, haul trucks, drill rig/compressors, and road-graders would be utilized to excavate gravel from the gravel mines. Snow removal equipment would be used as necessary. Bridge construction would require cement transit mixers for concrete tower construction.

Pipeline construction would involve the use of cranes, tractor-trailer trucks, welding equipment and other support equipment. Drilling rigs could be diesel-powered, utilizing fuel transported from CD-1. The drilling rigs will initially use diesel and then switch to high-line power as it becomes available.

Aircraft would bring materials and crew to CD-1, then by truck to the construction sites. The construction phase would require about 40 to 70 one-way aircraft flights per month initially, increasing to 180 in the summer of 2005, and peaking to 340 in the summer of 2006. Winter flights are anticipated to be 60 to 70 one-way trips per month. Table 2.3.10-1 presents Alternative A traffic estimates, which shows the breakdown of one-way aircraft flights per month for the construction, drilling, and operations phases of the applicant's proposed action.

Table 4A.2.3-5 shows emissions per landing/takeoff cycle (LTO) from a typical Twin Otter business turboprop aircraft, utilizing USEPA AP-42 emission factors for mobile sources for gas turbine engines specific to a Pratt Whitney PT6A-27 engine (USEPA 1985).

OPERATION PERIOD

Drilling operations would be a source of air emissions from diesel-powered electricity generators to power drill rig engines, and the space heaters and boilers used to heat the rig. Drilling also would occur during the construction period.

Criteria emissions associated with operation of the production pads would be from the combustion of diesel fuel, primarily as NO_x and CO, produced by the heaters and power generators. Final operating restrictions would be determined during permitting to ensure compliance with state and federal regulations. A gas-fired production heater would be installed at each of the five production pads (CD-3 through CD-7). Diesel-powered emergency backup generators would be installed at CD-3 and CD-6. A 3.1 MW power generator would also be installed at CD-6. The ACX-3 would be equipped with a Frame 5 turbine generator (36,700 hp), and possibly a gas-fired heater. These equipment items assume that all roads except CD-3 are accessible. If all pads are not road accessible, emergency generators would be added.

Air emissions would occur from fuel combustion as a result of operation of aircraft at the airstrips and from boat engines at the boat ramp. Aircraft flights during the drilling phase are anticipated during the winters at 70 to 90 one-way aircraft flights per month. Aircraft flights during the operational phase would start in summer of 2006 at about 24 one-way aircraft flights per month. Table 4A.2.3-5 presents a summary of estimated air emissions from aircraft flights.

The applicant's proposed action would not have consequential air emissions under normal operating conditions. The production pads would be subject to federal and state air quality regulations under the CAA. Section 109 of the CAA of 1970 required the USEPA to establish specific standards for the quality of ambient air (see Table 4A.2.3-6). To date, the USEPA has issued NAAQS for the ambient concentrations of six criteria pollutants: NO_2, SO_2, PM_{10} and $PM_{2.5}$, CO, ozone ($O_{3)}$, and lead. Alaska has adopted these federal standards. Strict adherence to applicable regulations would minimize the potential air quality impacts under Alternative A.

The existing APF-1 is permitted for equipment that is subject to federal NSPS, published in 40 CFR Part 60, including: Subpart Dc Small Industrial-Commercial-Institutional Steam Generating Units (dual-fired heaters rated at 20 MMBtu/hr); Subpart GG Standards of Performance for Stationary Gas Turbines (generator turbines); Subpart Kb Volatile Organic Liquid Storage Vessels (Tanks); and Subpart KKK Equipment Leaks of VOC from Onshore Gas Processing Plants. The USEPA is currently assessing the applicability of Subpart KKK at the request of CPAI. The air quality permit prescribes monitoring, record keeping, and reporting procedures for maintaining compliance with NSPS. As new equipment is added NSPS requirements could apply, such as Subpart GG to the Frame 5 turbine at ACX-3.

The existing APF-1 is considered an existing major source under the federal requirements of PSD new source review regulations. It is subject to PSD preconstruction review because net emission increases associated with the proposed project will exceed 40 tpy of NO_x or 100 tpy of CO.

TABLE 4A.2.3-5 CRITERIA POLLUTANT EMISSIONS FROM AIRCRAFT FLIGHTS, PER LANDING/TAKEOFF CYCLE (LTO) UNDER ALTERNATIVE A

Construction Phase[a]	Aircraft Flights (LTO)/month, one-way[b]	CO[c] (tons/year)	NO_x[d] (tons/year)	HC[e] (tons/year)	SO_x[f] (tons/year)
Winter 2004/05	70	0.251	0.029	0.178	0.006
Summer 2005	180	0.644	0.074	0.457	0.016
Winter 2005/06	60	0.215	0.025	0.152	0.005
Summer 2006	340	1.217	0.139	0.864	0.031
Winter 2006/07	70	0.251	0.029	0.178	0.006
Summer 2007	45	0.162	0.018	0.113	0.004
Winter 2007/08	50	0.179	0.021	0.127	0.004
Summer 2008	100	0.358	0.041	0.254	0.009
Winter 2008/09	50	0.179	0.021	0.127	0.004
Winter 2009/10	50	0.179	0.021	0.127	0.004
Summer 2010	85	0.306	0.034	0.213	0.007
Winter 2010/11	45	0.162	0.018	0.113	0.004
Drilling Phase					
Winter 2004/05	90	0.323	0.037	0.229	0.008
Winter 2005/06	90	0.323	0.037	0.229	0.008
Summer 2006	90	0.323	0.037	0.229	0.008
Winter 2006/07	90	0.323	0.037	0.229	0.008
Summer 2007	90	0.323	0.037	0.229	0.008
Winter 2007/08	90	0.323	0.037	0.229	0.008
Summer 2008	90	0.323	0.037	0.229	0.008
Winter 2008/09	90	0.323	0.037	0.229	0.008
Summer 2009	90	0.323	0.037	0.229	0.008
Winter 2009/10	90	0.323	0.037	0.229	0.008
Summer 2010	90	0.323	0.037	0.229	0.008
Winter 2010/11	90	0.323	0.037	0.229	0.008
Operations Phase					
Summer 2006	32	0.115	0.013	0.081	0.003
Winter 2006/07	16	0.058	0.006	0.040	0.001
Summer 2007	32	0.115	0.013	0.081	0.003
Winter 2007/08	16	0.058	0.006	0.040	0.001
Summer 2008	56	0.202	0.022	0.140	0.005
Winter 2008/09	24	0.086	0.010	0.061	0.002
Summer 2009	56	0.202	0.022	0.140	0.005
Winter 2009/10	24	0.086	0.010	0.061	0.002
Summer 2010	80	0.286	0.033	0.203	0.007
Winter 2010/11	32	0.115	0.013	0.081	0.003

Source: USEPA 1985

Notes:

Emissions were calculated for a DeHavilland Twin Otter turboprop aircraft (USEPA Class P2), Pratt & Whitney Model PT6A-27. Emissions factors are a composite of Table II-1-3 and Table II-1-5 in the source document, consisting of the following: 1) typical duration in minutes for civil aircraft LTO cycles at large congested metropolitan airports, based on taxi/idle out, takeoff, climbout, approach, taxi/idle (Table II-1-3); and 2) engine power settings for typical LTO commercial cycles by percentage thrust or horsepower (Table II-1-5).

[a] Summer = May through September; Winter = October through April

[b] One-way aircraft flights given are average (low-high) monthly estimates. One-way aircraft flights were used, in lieu of separate round trips, because flights could be linked from one pad to another. Summer/winter seasons that have no projected aircraft flights for that phase were not included.

[c] Carbon monoxide

[d] Nitrogen oxides reported as NO_2

[e] Total hydrocarbons – VOCs, including unburned hydrocarbons and organic pyrolysis products

[f] Sulfur oxides and sulfuric acid reported as SO_2

CPAI conducted dispersion modeling of the Alpine Development Project, including APF-1, to assess air quality impacts for its construction permit application submitted to the ADEC in July 2001. The model used was the Industrial Source Complex Short Term model, which is the USEPA's current regulatory model for air permitting applications. The model is based on a steady-state Gaussian plume algorithm, and its applications include point and area sources to a distance of approximately 50 kilometers. The analysis, based in conservative, worst-case assumptions, showed that the project would be in compliance with all Class II PSD increments and NAAQS. Additionally, there were no associated adverse impacts to soil, vegetation, and visibility. Impacts to Class I areas are expected to be negligible because the nearest Class I area is over 450 miles away at Denali National Park.

A revised air quality impact analysis for CD-3 and CD-4 was prepared in January 2004. Results of the dispersion modeling are presented in Tables 4A.2.3-7 and 4A.2.3-8. Since CD-3 and CD-4 represent the expected emissions from the proposed operational phase, Table 4A.2.3-7 indicates that a production pad site will not result in air quality impacts that exceed pollutant-by-pollutant PSD Class II increments. It is noteworthy that the maximum impacts are predicted to occur in the immediate vicinity of facilities. Thus overlapping air quality impacts for proposed production pads are limited.

Representative air quality impacts for the proposed operational phase compared to the NAAQS and AAAQS are provided Table 4A.2.3-8. The cumulative impacts of CD-3 and CD-4 along with existing facilities is representative of the proposed operational phase since these sources provide a reasonable "worst-case" alignment of emissions for a specific downwind receptor (i.e., village of Nuiqsut). As shown in Table 4A.2.3-8, the total air quality impacts (including model-predicted impacts from CD-3/CD-4, existing sources with background air quality levels) do not exceed the pollutant-specific NAAQS/AAAQS.

Under Alternative A – FFD, the potential does exist for the PSD Class II increments to be exceeded for those production pad sites in close proximity (i.e., within 3 miles) for annual NO_2 impacts and 24-hour PM_{10} impacts. In addition, significant impacts similar to those identified in Table 4A.2.3-7 (for CD-4) could occur in the vicinity of the village of Nuiqsut for a nearby site location such as HP-8. It is not anticipated that full-field development would result in a combined air quality impact that would cause concentration levels to exceed NAAQS or the AAAQS.

APF-1 is an existing major source under Title V of the CAA operating permit requirements (Part 70), with an annual potential to emit of 2,711 tpy of regulated air pollutants. The applicant's proposed action would trigger a modification to the Part 70 operating permit.

APF-1 is subject to NESHAP under Section 112 of the CAA, specifically Subpart E for mercury for its existing sludge incineration plants. Alternative A, however, would not trigger a major source of hazardous air pollutants (HAP) (either 10 tpy of a single HAP or 25 tpy of a combination of HAPs), so additional NESHAPs would not apply.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation would have impacts similar to those for construction if gravel pads, roads and the airstrip at CD-3 are removed. Impacts would be short-term and transient and will not have a lasting impact on air quality.

TABLE 4A.2.3-6 FEDERAL AMBIENT AIR QUALITY STANDARDS

Air Pollutant	Federal Primary Standard	Most Relevant Effects
	Concentration/ Averaging Time	
Ozone	0.12 ppm, 1-hr avg.,(235 µg/m^3)/ 0.08 ppm, 8-hr avg.[a] (157 µg/m^3)	(a) Short-term exposures: (1) Pulmonary function decrements and localized lung edema in humans and animals; (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide	9 ppm, 8-hr avg. (10 mg/m^3)/ 35 ppm, 1-hr avg. (40 mg/m^3)	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide	0.053 ppm, annual arithmetic mean (100 µg/m^3)	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide	0.030 ppm, annual arithmetic mean (80 µg/m^3)/ 0.14 ppm, 24-hr avg. (365 µg/m^3)	(a) Bronchoconstriction accompanied by symptoms which could include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma
Particulate Matter (PM_{10}) Particulate Matter ($PM_{2.5}$) [a]	50 µg/m^3, annual arithmetic mean/ 150 µg/m^3, 24-hr avg. 15 µg/m^3, annual arithmetic mean/ 65 µg/m^3, 24-hr avg.	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Excess seasonal declines in pulmonary function, especially in children
Lead	1.5 µg/m^3, calendar quarter	(a) Increased body burden; (b) Impairment of blood formation and nerve conduction

Sources: USEPA

Notes:

[a] The ozone 1-hour standard applies only to areas that were designated nonattainment when the ozone 8-hour standard was proposed in July 1997. This provision allows for a smooth, legal, and practical transition to the 8-hour standard. The ozone 8-hour standard and the PM $_{2.5}$ standards were recently promulgated after extended litigation and are included for information only until the USEPA can promulgate designations of attainment and nonattainment

Parenthetical value is an approximately equivalent concentration.

TABLE 4A.2.3-7 ALTERNATIVE A – EXPECTED OPERATIONAL PHASE IMPACTS FOR CD-3 AND CD-4 COMPARED TO PSD INCREMENTS

Pollutant	Averaging Time	Model Predicted Impact for CD-3 (µg/m^3)	Model Predicted Impact for CD-4 (µg/m^3)	PSD Class II Increment (µg/m^3)
NO_2	Annual	23.3	24.7	25
SO_2	3-hour	167	193	512
SO_2	24-hour	81.9	88.0	91
SO_2	Annual	8.0	8.0	20
PM_{10}	24-hour	21.1	23.9	30
PM_{10}	Annual	1.1	1.1	17

Notes:

Data from Revised Alpine Satellite Ambient Air Quality Impact Analysis for CD-3 and CD-4 (SECOR 2004) Tables 4-3 and 4-4.

Maximum impacts occur within immediate vicinity (<100 meters) of facility (generator, drilling rig, camp, pad).

TABLE 4A.2.3-8 ALTERNATIVE A – EXPECTED OPERATIONAL PHASE IMPACTS FOR CD-3 AND CD-4 COMPARED TO AAAQS/NAAQS

Pollutant	Averaging Time	Model Predicted Impact (μg/m^3)	Background (μg/m^3)	Total Impact (μg/m^3)	AAAQS/ NAAQS (μg/m^3)
NO_2	Annual	51.9	16	67.9	100
SO_2	3-hour	227	22	249	1,300
SO_2	24-hour	136	5	141	365
SO_2	Annual	9.13	0	9.1	80
PM_{10}	24-hour	53.4	33.6	87	150
PM_{10}	Annual	1.56	9.3	10.9	50
CO	1-hour	2,710	1,150	3,860	40,000
CO	8-hour	877	575	1,450	10,000

Notes:
Data from Revised Alpine Satellite Ambient Air Quality Impact Analysis for CD-3 and CD-4 (SECOR 2004) Tables 4-5 and 4-6.
Modeling includes offsite source inventory (existing facilities).
Maximum impacts occur within immediate vicinity (<100 meters) of facility (generator, drilling rig, camp, pad).

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON AIR QUALITY

Air pollutant emissions would be generated by two additional HPFs, possibly at the level of two times the current APF-1, which is permitted for 2,711 tpy of regulated pollutants. Modeling analysis of APF-1 demonstrated compliance with all applicable PSD increments and NAAQS. Additionally, the NSR regulatory framework administered by the ADEC would assure that activities performed under Alternative A – FFD would be in compliance with all applicable air quality regulations. Air quality impact analysis would be conducted under PSD preconstruction review, because the FFD expansion would trigger PSD emissions thresholds for NO_x and CO.

HAP emissions would also increase from installation of 22 drill site heaters and 22 emergency generators, along with the HAPs associated with the addition of two HPFs. Since HAPs are associated with total VOC emissions, it is unlikely that a single 10 tpy HAP source would result from implementation of Alternative A – FFD, so additional NESHAPS would not be required. Based on HAPs emissions from similar North Slope oil and gas production facilities, it is not anticipated that implementation of this alternative would be considered a major source of HAPs. Therefore, no NESHAP-related maximum achievable control technology (MACT) standards would apply.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON AIR QUALITY

Construction activities would contribute air emissions to the Plan Area. However, because they are short-term and transient in nature, they will not have a lasting impact to air quality. Aircraft landings and takeoffs would occur in all phases of either Alternative A or Alternative A – FFD, predominately during construction. Air quality impacts from aircraft trips, which would also be short-term and transient, are not regulated by the permitting process and are not expected to be significant. The ADEC requires that construction emissions meet all applicable NAAQS.

The applicant's proposed action would not emit consequential air pollutants under normal drilling and operating conditions. Impacts from Alternative A – FFD would be more substantial because of the addition of two HPFs and would be subject to critical non-source review (NSR) that requires demonstrated compliance with PSD increments, NAAQS, and USEPA emission control requirements.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR AIR QUALITY

Air quality impacts, including fugitive dust, would be limited through the permitting process, which ensures that no significant new air pollution sources contribute to a deterioration of the ambient air quality. Mitigation measures for limiting fugitive dust would include road watering, vehicle washing, covering of stockpiled material, ceasing construction during wind events, and the use of chemical stabilizers. These measures may vary for the frozen season and nonfrozen season. Dust may be reduced by utilizing sealing agents and chip-seal on pads, runways and heavily utilized portions of the road system. Watering of dust prone areas would also reduce dust associated with the project.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR AIR QUALITY

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS developed specifically for limiting air quality impacts. Agency permitting processes are designed to limit air quality impacts. The EIS has identified mitigation measures such as road watering, vehicle washing, covering of stockpiled material, ceasing construction during wind events, and the use of chemical stabilizers and sealing agents. These measures could greatly lessen impacts to air quality caused by fugitive dust that is generated during both the construction and operation phases of the project.

4A.2.3.3 Noise

The following noise analysis focuses on impacts to sensitive areas, which are defined at communities. Nuiqsut is the community nearest the proposed development. However, local residents travel widely over the Plan Area, pursuing subsistence activities. Additional information regarding the impacts of noise on subsistence users can be found in Section 4A.4.3.1.

Noise quality can be affected during construction, drilling, and operations phases of a project. The ambient sound level of a region is defined by the total noise generated, including sounds from both natural and artificial sources. The magnitude and frequency of environmental noise could vary considerably over the course of the day and throughout the week, in part because of changing weather conditions. Federal agencies use two measurements to relate the time-varying quality of environmental noise to its known effect on people: Leq$_{(24)}$ and Ldn. The Leq$_{(24)}$ is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. The L_{dn} is the Leq$_{(24)}$ with 10 dBA added to nighttime sound levels between the hours of 10 p.m. and 7 a.m., to account for people's greater sensitivity to sound during nighttime hours.

The basis for evaluation of noise impact is an L_{dn} of 55 dBA, the level that protects the public from indoor and outdoor activity interference in residential areas. Noise impact must be mitigated if, during operations, noise attributable to the operation of the facility would exceed an L_{dn} of 55 dBA at nearby noise sensitive areas such as residences, or if applicable state and local noise regulations would be exceeded.

To assess noise impacts, an evaluation of the following significance criteria is conducted to determine if the applicant's proposed action would:

- Expose persons to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
- Expose persons to or generate excessive groundborne vibration or ground-borne noise levels
- Create a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project
- Create a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project

- Expose people residing or working in the Plan Area to excessive noise levels for a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport
- Expose people residing or working in the Plan Area to excessive noise levels, for a project within the vicinity of a private airstrip

In community noise impact analysis, a long-term noise increase of 5 to 10 dBA is considered to impact the noise quality of the community to some degree. Most people begin to notice changes in environmental noise at about 5 dBA. Noise levels below 5 dBA cannot definitively be demonstrated as producing an adverse impact. Noise level increases above 10 dBA are generally considered to have a severe impact. For short-term noise increases (for example, construction activities), the typical severe threshold increase is 15 dBA, depending upon whether the noise level fluctuates, has a high frequency, or is accompanied by subsonic vibration.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN NOISE IMPACTS

CONSTRUCTION PERIOD

Construction is expected to be typical of other development projects in terms of schedule, equipment used, and other types of activities. It is expected that construction would increase noise levels in the vicinity of the Plan Area. Project construction noise levels would vary during the construction period, depending on the construction phase. Construction equipment would be operated on an as-needed basis during this period and would be maintained to manufacturer's specifications to minimize noise impacts. Although individuals in the immediate vicinity of the construction activities would experience an increase in noise, this effect would be local and temporary, lasting only during days of construction (primarily winter) and, other than drilling, usually occurring at a given location for only part of one winter season. Drilling for CD-3 would occur in five to seven successive winters, that at CD-4 over four successive summers, and other pads over approximately 1.5 years.

The construction of gravel roads, drilling and production pads, and pipelines would cause temporary increases in the ambient sound environment in the immediate vicinity of the construction sites. Typical construction equipment, such as a dump truck, backhoe, concrete mixer, and other trucks and cranes, creates noise levels of about 85 to 91 dBA at a distance of 50 feet (USEPA 1971). Grading activities, however, would mitigate noise caused by loud rattling of truck travel on potholed roads.

During drilling activities, excessive groundborne vibration or groundborne noise levels could be generated from drill rigs, where noise levels would be about 82 to 92 dBA at a distance of 82 feet (Hampton et al. 1988). However, drill rigs are totally enclosed with windwalls and arctic insulation, which provides adequate soundproofing to noise exposure outside the rig complex. Enclosure and winterization of rigs should reduce the drilling operation noise impacts to 70 dBA or below outside the operational area. The nearest sensitive area is the village of Nuiqsut, which is approximately 5 miles south of CD-4.

Noise would affect the local environment during construction or extension of the proposed access roads. Construction would proceed at rates ranging from several hundred feet to several miles per day. However, because of the assembly line method of construction, activities in any one area could last several weeks. Construction equipment would be operated on an as-needed basis during this period. Although individuals in the immediate vicinity of the construction activities could experience annoyance, the impact on the noise environment at any specific location along the route would be short-term.

Noise associated with the construction or extension of access roads and aboveground pipelines would be intermittent during the construction period at any single location and would vary from hour to hour depending on the equipment in use and the operations being performed. The overall impact would be temporary and would not be expected to be significant.

The development process for Clover, identified to provide gravel for road and pad construction associated with CD-5, CD-6, and CD-7, would include blasting and excavation of gravel. Blasting would result in a temporary increase of noise level. Typical noise levels for blasting would be approximately 94 dBA at a distance of 50 feet, and decreases to below 70 dBA at a distance of 800 feet (Jones & Stokes 2003). The nearest sensitive area is the village of Nuiqsut, which is about 6.5 miles east-southeast of the gravel source.

OPERATION PERIOD

During operational drilling, the potential noise impacts would be limited to the vicinity of the power generation engines and drilling rig engines, which would have equipment decibel ratings of about 85 dBA and 110 dBA, respectively. Principal noise sources would include the air inlet, exhaust, and casing of the engines or turbines. Secondary noise sources would include cooling fans, yard piping, and valves. Noise from relief valves and emergency electrical generation equipment would be infrequent.

Generally, the equipment in the Plan Area will operate at a decibel level of about 70 dBA from less than 1,000 feet if properly mitigated by noise minimization measures such as mufflers on the exhaust systems of engines and turbines. With noise mitigation there will not be long-term impacts to the nearby village of Nuiqsut. Workers in the Plan Area would be subject to Occupational Safety and Health (OSHA) standards for hearing protection as necessary.

Operation of the access roads after construction would not significantly exceed their use. The applicant’s proposed action will utilize a small twin-engine aircraft. In 1997, the use of a small aircraft was evaluated versus a larger Boeing 737 for crew transport. The Boeing 737 could transport 120 passengers compared to 19 passengers onboard the small aircraft. However, the smaller aircraft was selected to mitigate noise impacts to residents in the nearby village of Nuiqsut. However, this noise mitigation measure requires more trips to transfer crew and materials.

The highest use of the CD-3 airstrip would occur during non-ice road months for material re-supply. During the summer, a small twin-engine fixed wing aircraft would be utilized to transport operation and maintenance personnel to the site. A higher frequency of use would occur during production start-up, after which it would decline at a steady rate. Twin-engine propellers at 1,000 feet emit a noise level of 69 to 81 dBA. Table 4A.2.3-5 indicates the estimated one-way aircraft flights per month. The noise impacts from the use of aircraft during construction would be considerably greater than during the operational phase, where 24 one-way aircraft flights per month are projected.

Noise levels from passing helicopters vary among aircraft models and atmospheric conditions. Typically, the noise from passing helicopters ranges between 68 to 78 dBA during a flyover (at about 1,300 feet) but is only detectable for 30 seconds.

ABANDONMENT AND REHABILITATION

Noise impacts are expected to be similar to those associated with construction, minus the impacts of drilling, which produces some of the greatest noise impact. Abandonment and rehabilitation noise would be intermittent at any single location and vary depending on the equipment in use and the operations being performed. The level of impact would be less than construction if gravel fill is not removed.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO NOISE IMPACTS

Additional construction and drilling at the two HPFs and the 22 HPs would extend the noise impacts over a longer period of time and over a wider area. Additional aircraft trips during construction would occur under the Alternative A – FFD Plan. Since the village of Nuiqsut is several miles from all but one of the HPs, noise impacts would be minimal.

ALTERNATIVE A – SUMMARY OF NOISE IMPACTS (CPAI AND FFD)

During peak periods of construction and drilling, noise levels would be considerably higher than during operations, but would be short-term, and would not occur for all HPs at the same time. The village of Nuiqsut is approximately 5 miles from the nearest proposed development, so noise impacts would be minor unless, under Alternative A – FFD, a development occurred much closer to the village.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR NOISE

No potential mitigation measures have been identified.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR NOISE IMPACTS

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS nor were potential mitigation measures developed in this EIS.

4A.3 BIOLOGICAL RESOURCES

4A.3.1 Terrestrial Vegetation and Wetlands

4A.3.1.1 Alternative A – CPAI Development Plan Impacts on Terrestrial Vegetation and Wetlands

Impact areas for vegetation and habitats under the CPAI Development Plan were calculated based on Geographic Information System (GIS) maps in ArcView® 8.3 (2003, ESRI, Redlands, California). Both direct and indirect impact areas were calculated. Placement of gravel fill for the constructions of roads, pads, and airstrips results in the direct loss of vegetation and habitat. This direct loss was estimated by overlaying the footprints (perimeter) of roads, pads, and airstrips for CPAI alternatives on the ABR, Inc. vegetation map (Figure 3.3.1.2-1) (Jorgenson et al., 1997, 2003c) and the habitat map (Figure 3.3.1.3-1) (Jorgenson et al. 2003c), and calculating the area of each vegetation class and habitat type within these footprints. Dust fallout, snow accumulation, changes to moisture or thermal regimes, and trenching result in indirect changes in the amount of cover or plant species composition. Indirect impacts due to dust fallout and changes to moisture and thermal regimes were calculated by using GIS to generate a 164 foot (50 meter) buffer area around the outside of the gravel footprint areas for CPAI alternatives (Hettinger 1992; BLM and MMS 1998a, 2003). Indirect impact buffers were then overlain on the vegetation and habitat maps, and the area of each vegetation class and habitat type were calculated. Under Alternative B, where power lines are proposed to be buried in the tundra next to pipelines, a 1-foot wide strip centered on the pipeline was generated and overlain on the vegetation and habitat maps to calculate the area of impact for vegetation classes and habitat types. Results of these analyses are presented in Tables 4A.3.1-1, 4A.3.1-2, 4B.3.1-1, 4B.3.1-2, 4C1.3.1-1, 4C1.3.1-2, 4C2.3.1-1, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, and 4F.3.1-2.

The project design would minimize the facility footprints to reduce the loss of vegetation and habitat from gravel placement and associated indirect impacts. Biologists, geologists, and facilities and reservoir engineers worked together combining information from waterbird distribution maps and wildlife habitat maps based on physical features (surface landforms, soil types, and vegetation types) to locate facilities in drier habitats avoiding impacts to aquatic, nonpatterned Wet Meadow, Patterned Wet Meadow, and Moist Sedge-Shrub Meadow habitats preferred by many waterbirds (CPAI 2004). Figures 4A.3.1-1 and 4A.3.1-2 show vegetation and habitat potentially affected, and Table 4A.3.1-1 and Table 4A.3.1-2 summarize the area of vegetation classes and habitat types affected under the Alternative A – CPAI Development Plan. All impacts under Alternative A would be to wetlands. Key wetland habitats correlated to those identified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b) are described in Section 3.3.1 and identified in Table 4A.3.1-2. Oil spills, should they occur, would also directly or indirectly affect vegetation and wetlands in the Plan Area. The impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

See Section 2.7 (Table 2.7-1) for a comparison of impacts to tundra habitats in the Plan Area among alternatives.

CONSTRUCTION PERIOD

The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Gravel facilities would be designed and constructed as described in Section 2. Under Alternative A, a total of approximately 241 acres of tundra vegetation would be covered with gravel fill for the construction of well pads (49 acres), approximately 26 miles of primary and spur roads (174 acres), and an airstrip runway and apron at CD-3 (16.3 acres). In addition to impacts from roads, pads, and an airstrip, approximately 1.5 acres of tundra vegetation would be lost for the construction of a boat launch ramp at CD-4 and the associated access road, and a floating dock and access road at CD-3 as described in Section 2.3.8. Gravel facilities would be constructed and maintained to hold their designed dimensions; however, some gravel slumping from side-slopes could occur, which could potentially increase the impact area by approximately 16 percent (assuming a maximum increase from a 2H:1V to a 3H:1V side slope). The type of impact from gravel slumping could range from direct loss of tundra vegetation to an alteration of vegetation communities depending on the thickness of gravel sloughed onto adjacent tundra. These potential impacts are included in the indirect impact area calculations from dust, gravel spray, snowdrifts, impoundments, and thermokarst discussed below. Abandonment of roads, pads, and airstrips is discussed in Section 2.3. Vegetation classes and habitat types lost under Alternative A due to gravel placement are summarized in Tables 4A.3.1-1 and 4A.3.1-2.

Gravel for the proposed development would be mined from two locations. The ASRC Mine Site is already permitted as a gravel source with a reclamation plan in place. The reclamation plan would be amended to reopen the mine to supply material for the CD-3 and CD-4 sites; however, no expansion to the existing permitting area is currently planned. Vegetation at the ASRC Mine Site is composed of Deep Polygon Complex and Wet Sedge Meadow Tundra with the following corresponding habitat types: Deep Open Water without Islands, Shallow Open Water without Islands, Aquatic Sedge with Deep Polygons, Patterned Wet Meadow, and Nonpatterned Wet Meadow. Gravel for the CD-5, CD-6, and CD-7 sites would be mined from Clover, approximately 6 miles southeast of CD-6, impacting approximately 65 acres of tundra vegetation. This is a maximum case scenario and the actual acres impacted from mining at Clover would be less because some of the gravel would be extracted from the currently permitted ASRC Mine Site for the CD-3 and CD-4 sites. Clover would require permitting and a reclamation plan (Appendix O) prior to development. The vegetation at Clover is composed primarily of Moist Sedge-Shrub Tundra and Tussock Tundra with less than 10 percent of Wet Sedge Meadow Tundra. Dominant habitat types include Moist Sedge-Shrub Meadow and Moist Tussock Tundra with less than 10 percent of Nonpatterned and Patterned Wet Meadow. Removal of gravel from the ASRC Mine Site and Clover would result in a permanent loss of tundra habitat while the mine sites are active, and an alteration from tundra to aquatic habitat when the gravel sites are reclaimed. Specific details on the changes in habitat resulting from gravel extraction at Clover are provided in the reclamation plan (Appendix O). These plans would be reviewed and approved by local, state (for ASRC), and federal agencies.

The type of gravel material used for pads, airstrips, and roads could also affect vegetation, especially if the material has a high salt concentration. Water (e.g., rain) draining off or leaching through saline pad material dissolves the salt and could cause physiological stress to nearby plants (Simmons et al. 1983, McKendrick 1996). Saline gravels have been identified as a source of tundra damage along the Tarn Road, south of the Kuparuk Oilfield (McKendrick 2003a). Salinity of soils adjacent to the road the first summer after construction (8.69 milli mhos per centimeter (mmhos/cm) or ~5 ppt) were reduced by 69 percent during the next fall (2.66 mmhos/cm or ~1.5 ppt) as was the visible impact to vegetation (McKendrick 2003a). These observations suggest that soluble salts from gravel fill will be flushed from tundra soils and that vegetation impacts, at least at these salinities, will be temporary (McKendrick 2003a). Salinity measurements taken from borings in the ASRC Mine Site and the Clover ranged from 0 to 3 ppt and 0 to 9 ppt, respectively.

TABLE 4A.3.1-1 CPAI ALTERNATIVE A – SUMMARY OF SURFACE AREA (ACRES) OF VEGETATION CLASSES AFFECTED

Vegetation Classes	Colville River Delta							NPR-A (Western Beaufort Coastal Plain)					Totals for Alternative A
	Direct Impacts					Indirect Impacts	Totals for Delta	Direct Impacts			Indirect Impacts	Totals for NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal		Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal		
Water	2.1				<0.1	17.7	19.8	0.2			4.2	4.4	24.1
Riverine Complex								0.5			3.6	4.1	4.1
Fresh Grass Marsh						1.6	1.6						1.6
Fresh Sedge Marsh								0.8			6.8	7.6	7.6
Deep Polygon Complex				5.3		10.0	15.3						15.3
Young Basin Wetland Complex								2.1		2.5	14.5	19.1	19.1
Old Basin Wetland Complex								5.0			37.9	42.9	42.9
Wet Sedge Meadow Tundra	16.5	1.6	21.9	11.0	0.1	159.7	210.8	15.4	0.4	6.2	107.5	129.5	340.4
Salt-killed Wet Meadow													
Halophytic Sedge Wet Meadow						0.5	0.5						0.5
Halophytic Grass Wet Meadow													
Moist Sedge-Shrub Tundra	9.0					60.8	69.8	29.2	0.4	0.8	176.8	207.1	276.9
Tussock Tundra	1.1						1.1	76.1	2.2	17.1	486	581.3	582.4
Dryas Dwarf Shrub Tundra													
Cassiope Dwarf Shrub Tundra													
Halophytic Willow Dwarf Shrub Tundra													
Open and Closed Low Willow Shrub	6.9				1.1	26.1	34.1	3.2		0.7	21.4	25.3	59.4
Open and Closed Tall Willow Shrub								0.2			1.3	1.5	1.5
Dune Complex													
Partially Vegetated					0.2	9.2	9.4						9.4
Barrens	1.1					7.0	8.1						8.1
Total Area	**36.6**	**1.6**	**21.9**	**16.3**	**1.5**	**292.5**	**370.4**	**132.6**	**2.9**	**27.4**	**859.9**	**1,022.8**	**1,393.2**

Notes:

Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.

Calculation methods are described in text in Section 4A.3.1.1.

Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

Table 4A.3.1-2 CPAI Alternative A – Summary of Surface Area (Acres) of Habitat Types Affected

Habitat Types	Colville River Delta							NPR-A (Western Beaufort Coastal Plain)					Totals for Alternative A
	Direct Impacts					Indirect Impacts	Totals for Delta	Direct Impacts			Indirect Impacts	Totals for NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal		Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal		
Open Nearshore Water													
Brackish Water													
Tapped Lake with Low-water Connection													
Tapped Lake with High-water Connection						1.0	1.0						1.0
Salt Marsh*						0.5	0.5						0.5
Tidal Flat*													
Salt-killed Tundra*													
Deep Open Water without Islands*						1.3	1.3	<0.1			0.9	0.9	2.2
Deep Open Water with Islands or Polygonized Margins*	1.1					7.0	8.1				0.3	0.3	8.4
Shallow Open Water without Islands	0.3					1.4	1.7				0.2	0.2	1.9
Shallow Open Water with Islands or Polygonized Margins								0.1			2.2	2.3	2.3
River or Stream	0.7				<0.1	7.0	7.7	0.1			0.6	0.7	8.4
Aquatic Sedge Marsh								0.8			6.8	7.6	7.6
Aquatic Sedge with Deep Polygons				5.3		10.0	15.3						15.3
Aquatic Grass Marsh*						1.6	1.6						1.6
Young Basin Wetland Complex*								2.1		2.5	14.5	19.1	19.1
Old Basin Wetland Complex*								5.0			37.9	42.9	42.9
Riverine Complex*								0.5			3.6	4.1	4.1
Dune Complex													
Nonpatterned Wet Meadow	4.1	0.8	7.6	1.8		46.2	60.5	1.5		5.9	17.2	24.5	85.1
Patterned Wet Meadow	12.4	0.8	14.3	9.2	0.1	113.5	150.3	14.0	0.4	0.3	90.4	105.1	255.4

TABLE 4A.3.1-2 CPAI ALTERNATIVE A – SUMMARY OF SURFACE AREA (ACRES) OF HABITAT TYPES AFFECTED (CONT'D)

Habitat Types	Colville River Delta							NPR-A (WESTERN BEAUFORT COASTAL PLAIN)					Totals for Alternative A
	Direct Impacts					Indirect Impacts	Totals for Delta	Direct Impacts			Indirect Impacts	Totals for NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal		Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal		
Moist Sedge-Shrub Meadow	9.0					60.8	69.8	32.3	0.4	1.5	197.9	232.1	301.9
Moist Tussock Tundra	1.1						1.1	76.1	2.2	17.1	486.0	581.3	582.4
Riverine Low and Tall Shrub*						1.2	1.2	0.3			1.6	1.9	3.1
Upland Low and Tall Shrub													
Upland and Riverine Dwarf Shrub*													
Riverine or Upland Shrub*	6.9				1.1	24.9	32.9						32.9
Barrens (riverine, eolian, or lacustrine)	1.1				0.2	16.1	17.3						17.3
Artificial (water, fill, peat road)													
Total Area	36.6	1.6	21.9	16.3	1.5	292.5	370.4	132.6	2.9	27.4	859.9	1,022.8	1,393.2

Notes:
Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.
Calculation methods are described in text in Section 4E.3.1.1
Columns may not sum to exact numbers in the total row because of rounding, particularly when habitat types have impacts of <0.1.
* Represents key wetland habitats that were correlated to Bergman et al. (1977) habitats and riparian shrub habitats identified as key wetlands in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b)

DUST FALLOUT FROM ROADS

Although much of the traffic would occur during the construction season, most would be during the winter on ice roads. However, summer traffic during construction would be required for module hookups, pipeline work, and roadwork. Summer construction traffic, which would produce the most dust, is expected to decrease after the first construction season (Johnson et al. 2003a).

On gravel roads, vehicle traffic results in dust and gravel being sprayed over the vegetation within about 35 feet of the road as well as a noticeable dust shadow out to about 150 feet or more (Walker and Everett 1987, Hettinger 1992). Accumulated dustfall has no soil structure, is massive, and often has poor aeration and limited water filtration (McKendrick 2000b). Various studies on dust fallout have found early snowmelt, reduced soil-nutrient concentrations, lower moisture, altered soil organic horizon, and higher bulk density and depth of thaw in soils where dust shadows occur (Everett 1980, Walker and Everett 1987, Hettinger 1992, Auerbach et al. 1997). These studies reported reduced richness of plant species near the road especially in naturally acidic soils. Heavy dust accumulation can eliminate acidophilus mosses (Walker and Everett 1987, Hettinger 1992, Auerbach et al. 1997), and prostrate willow (McKendrick 2000b). Lichens are sensitive to dust and are often eliminated in high dust areas (Walker and Everett 1987). Within 35 feet of roads, the dust and gravel may smother the original vegetation, altering the plant communities, and at extreme levels may eliminate all vascular plants (Auerbach et al. 1997, McKendrick 2000b). Beyond about 35 feet, the effects of dust on vegetation decrease logarithmically with distance from the road out to about 1,000 feet. Multiple-year studies of the effects of a gravel oilfield road in Prudhoe Bay resulted in an increase in graminoid cover and a decrease in shrub and lichen cover within 164 feet (50 meters) of the road in response to increased moisture, a deeper active layer, and increased nutrients, but that few changes in flora were attributable to dust alone (Hettinger 1992). Areas beyond this distance are essentially undisturbed (Everett 1980).

Under Alternative A, indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst would result in alteration of about 1,152 acres of tundra vegetation, assuming that these impacts occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area by vegetation and habitat types within this impact area. The impacts from dust would be reduced by scheduling construction and associated traffic in the winter when dust from the road would be less, and watering roads during the summer (a standard North Slope practice) to keep dust down and maintain road bed integrity. Chip seal could also be used to minimize impacts to vegetation from road dust. Chip seal coated roads are an intermediate step between gravel and asphalt roads, which would minimize dust created by wind or vehicles driving over the road. Chip seal is applied by first applying a heavy layer of a bituminous binder that is sprayed on the road with an oil distributor. The chipper is filled with a special gravel mixture (aggregate) which spreads the chips evenly onto the binder. Rubber tired and steel packers are then used to compact the aggregate. When the oil is set, the loose chips are swept away to produce a finished surface. Impacts on roadside vegetation and water quality during the chip sealing process could potentially occur if it rains before the binder can cure (causing runoff into adjacent surface water), or with excessive application rates. These impacts are very unlikely when common construction practices are applied (EPA 2004). There are many precautionary measures that can be taken to avoid any impact on the surrounding environment:

- Obtain weekly forecast prior to planned sealing and try to time spraying so it does not coincide with rainfall during or immediately after sealing.
- Distribute hydrocarbon barriers and sediment bags for use immediately after sealing.
- Ensure correct bitumen application and spray rates to avoid over-spraying and waste.
- Sweep up loose materials immediately upon finishing, and routinely as required.
- Ensure that trucks carrying liquid asphalt, particularly hydrocarbon-thinned materials, carry absorbent spill kits.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Ice roads have been used to minimize damage to the tundra surface since the early 1970s. Construction of ice roads and subsequent use may disturb underlying vegetation. Shrubs, forbs, and tussocks may be damaged and occasionally killed. Compaction of tundra vegetation by ice roads and associated gravel hauling and other construction activities can affect tundra habitats for several years by crushing tussocks, breaking and abrading willow terminal ends, and by altering or destroying the intertussock plant community, particularly the mosses and lichens (Walker 1996). Compaction of vegetation could also alter drainage, cause impoundment of meltwater, alter the thermal regime, and cause thaw settlement (Felix et al. 1992). Overall, studies of ice roads have found impacts to tundra vegetation to be low, with sporadic patches of moderate-level impacts, and slight or no significant increases in thaw depths (Walker et al. 1987a, Payne et al. undated, Pullman et al. 2003). Habitats sensitive to compaction include Moist Tussock Tundra, Riverine or Upland Shrub, and Moist Sedge-Shrub Meadows (Felix and Raynolds 1989a, Emers et al. 1995, PAI 2002). Pullman et al. (2003) found that tussock tundra was the most sensitive to damage primarily due to the higher micro relief caused by tussocks and the subsequent potential for scuffing and crushing from heavy equipment. Vegetation with negligible or low-level impacts from ice roads remains greener longer in the fall and can be readily visible from the air as "green trails" (Pullman et al. 2003). This indicates the effects of late-melting ice, which delays the typical plant phenology (the relationship of climate and seasonal cycle) (McKendrick 2000a, 2003b). "Brown trails" associated with moderate-level damage due to scuffing and crushing of tussocks may be visible from the air for years; however, this disturbance has a good potential for full recovery (Pullman et al. 2003). In general, more significant damage from ice roads occurs on higher, drier sites, with little or no evidence of damage to wet or moist wetland sites (Payne et al. undated, BLM 2002). Shrubs and other woody species are affected the most by ice road construction (BLM 2002). Studies conducted on the effects of ice road river crossings on willow stands (McKendrick 2000a, 2003b) reported impacts such as delayed phenology from lingering ice cover, broken and dead limbs, and a few dead plants. Damaged willows recovered on their own from single-year ice roads (McKendrick 2000a, 2003b). Long-term vegetation modification could result from repeated use of the same location for ice road construction (BLM 2002). However, a pilot study conducted by the BLM found no apparent difference between single-year ice roads and an overlapping area from two subsequent years of ice roads (Yokel et al. undated [b]). Offsetting ice road paths, year after year, would create a greater surface area of disturbance. Tundra recovery rates are variable and depend on the initial level of disturbance and vegetation types (Yokel et al. undated, Jorgenson et al. 2003a). Evergreen shrubs (which generally are slow growing plants) in Dryas Dwarf Shrub and Moist Sedge-Shrub habitats and deciduous shrubs in Low Willow Shrub habitats tend to recover at slower rates (Jorgenson et al. 2003a, Jorgenson et al 2003b). All impacts from single-year ice roads are expected to completely recover over a twenty to twenty-four year period (Jorgenson et al. 2003b, Payne et al. undated [a]).

Under Alternative A, a total of about 239 miles of temporary ice roads would be constructed over the life of the project for construction-related activities, resulting in a maximum of approximately 1,159 acres of vegetation disturbed. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year as required by existing stipulations on BLM-administered land. The actual surface area disturbed would likely be much less, especially if ice roads are overlapped in subsequent years to minimize impacts. Ice roads placed for the construction of gravel roads and pipelines would follow adjacent to the road/pipeline routes and would tend to affect the same habitat and vegetation types (see Tables 4A.3.1-1 and 4A.3.1-2). Winter ice roads would be designed and located to minimize the breakage, abrasion, compaction, or displacement of vegetation. To mitigate vegetation impacts by minimizing the surface area of disturbance, the most direct route would be taken and, when possible, shrub areas would be avoided.

In addition to ice roads, ice pads would be used as staging areas during pipeline construction. Approximately 74 acres of vegetation would be disturbed by ice pad staging areas for the construction of the pipeline. Ice pads may also be used to stockpile overburden material associated with the ASRC Mine Site. The ice pads would be constructed directly adjacent to the mine sites and would tend to affect the same vegetation types as would gravel extraction activities from the mine sites. The size of the ice pads would depend on the depth of overburden soils and the volume of underlying gravel to be extracted. As described in Section 2, overburden removed from the ASRC Mine Site during previous operations required about 1 acre for every 25,000 cg of overburden. Ice pads also would be constructed at each end of each proposed bridge to stage equipment. These ice pads used as staging areas would vary with the size of the bridge installation and equipment needs. Given the number of access road bridges proposed under the Alternative A–CPAI Development Plan , and assuming the maximum pad size would be 800 feet by 800 feet surrounding the abutment structure at each end of a bridge (see Section 2.3, Features Common to all Alternatives), then a maximum of 206 acres of vegetation would be affected by these ice pads. Ice pads could also be built for storage of drill rigs and other equipment at remote production pads. It is assumed that the effects of ice pads on vegetation would be similar in type to the effects of ice roads.

Snowdrifts or plowed snow that accumulates on tundra adjacent to roads, well pads, pipelines, and airstrips can be deep and may persist longer than snow in areas away from gravel structures. In areas where snow persists late into the growing season, vegetation growth would be delayed. As with ice roads, vegetation composition is typically not altered in areas with late-melting snow piles, but the vegetation tends to remain green later than usual at the end of the growing season (McKendrick 2000b). Pipelines elevated 5 feet or more prevent accumulation of snowdrifts during winter (Pullman and Lawhead 2002).

OFF-ROAD TUNDRA TRAVEL

Development and operation of oil facilities in the Plan Area may require access across tundra. Such access could be necessary to respond to spills or other emergencies, conduct pipeline maintenance and repair, facilitate ice road construction, or to transport supplies and equipment to roadless development sites. Winter tundra travel by ice roads is discussed above.

Off-road tundra travel, especially during the summer, could cause impacts to ground stability and vegetation, including compaction, disruption of the surface layer, damage to willow cover, and scarring of the surface layer (PAI 2002).

Impacts associated with tundra travel by low-pressure vehicles (e.g., Rolligons) range from low-level disturbances such as “green” trails caused by the compaction of dead plant material, to high-level disturbances indicated by scuffing and breakage of vegetation. The range of disturbance is generally dependent on vegetation type. An assessment of impacts associated with a heavily used Rolligon trail in the Northeastern National Petroleum Reserve-Alaska (Jorgenson et al. 2003b) showed low-level disturbances were common in moist sites such as Wet Sedge Meadow and Sedge-Shrub Tundra, moderate disturbances were more common in Tussock Tundra, and high-level disturbances occurred only in shrub-dominated vegetation types such as Low Willow Shrub and Dwarf Shrub Tundra. Sites with low to moderate-levels of initial disturbance are expected to recover in three to five years. Shrub-dominated sites with moderate to high-level initial disturbance could take up to twenty years to recover (Jorgenson et al. 2003b).

Most research on the effects of winter tundra travel focused on seismic exploration trails (Emers and Jorgenson 1997; Emers et al. 1995; Felix and Raynolds 1998a, 1989b; Jorgenson 2000; Jorgenson et al. 1996; Jorgenson et al. 2003a). Vehicles used for seismic exploration have been modified over the years to minimize impacts to the tundra and although seismic exploration is not proposed for this project, the more recent studies can be used to show the type of impacts to tundra vegetation from modern winter tundra travel vehicles. Jorgenson et al. (2003a) used a rapid, semi-quantitative ranking approach to assess the levels of disturbance at sites associated with seismic exploration near the Colville Delta in 2001. During this survey, rubber-tired vehicles were used for vibrator lines, rubber-tracked vehicles were used for all surveying and receiver equipment, and three-tracked vehicles (D-7) and rubber-tracked tractors were used to pull the camp strings. The overall disturbance levels for the Colville Delta 2001 seismic survey were low. The degree of impact varied among both trail types and vegetation types. In particular there were few occurrences of moderate or higher level disturbances along the receiver and vibrator trails which used similar rubber-tired and rubber-tracked equipment that would be used with CPAI’s proposed action. Tundra that is shrub dominated or with tussocks or hummocks (Tussock Tundra, Low Willow Shrub, and Dryas Dwarf Shrub Tundra) has been shown to be more susceptible to initial disturbance than low-relief sedge-dominated tundra (Wet Sedge Meadow Tundra and Moist Sedge-Shrub Tundra) (Jorgenson et al. 1996, Jorgenson et al. 2003a, Jorgenson et al. 2003b). Jorgenson et al. (1996) showed that disturbance levels on winter seismic lines and camp-move trails decreased greatly over time and that the main long-term damage to tundra was from the heavier vehicles (10.5 pounds per square inch [psi]) used for camp-moves. Similar results have been reported for summer tundra travel (Lawson et al. 1978, Walker et al.

1977, Everett et al. 1985); however, the impacts from summer tundra travel can be more severe because the lack of snow makes the tundra more exposed to disturbance.

Impacts from off-road tundra travel during both summer and winter would be mitigated and avoided by limiting the number of vehicle passes in an area, and avoiding tight turns. Low-ground-pressure vehicles (less than 4 psi) approved for travel by state and federal regulators would be used. Low-pressure vehicles such as Rolligons, Tuckers, and Nodwells would conduct these activities from the nearest pad or road. Restrictions to tundra travel are implemented by state, federal, and local regulators. All applicable permits and approvals would be obtained prior to tundra travel, and the permit stipulations would be followed. Existing procedures for emergency summer tundra travel would be maintained onsite during construction and operation.

IMPOUNDMENTS AND THERMOKARST

Impoundments are created where gravel fill or overburden placed on the tundra surface blocks the downslope movement of water. Although drainage plans, project design, culvert installation, and maintenance have reduced the occurrence of impoundments or ponding on the North Slope, temporary blockages, especially during spring snow melt, are still possible. Some blockages simply increase soil moisture on the upslope side of the barrier, potentially causing the substrate to become drier on the downslope side, while others create ponds. Impoundments may be ephemeral and dry up early during the summer, or they may become permanent water bodies that persist from year to year (Walker et al. 1987a, Walker 1996). Wetland associated with ice-wedge polygons and low-lying, vegetated thaw-lake basins are more susceptible to impounding than higher, moist tundra (Walker et al. 1987a). Hydrological changes are reflected in the vegetation, with sharp contrasts in vegetation type from one side of a road to the other. Tundra plant communities have evolved under naturally changing moisture regimes, so are pre-adapted to accommodate analogous man-induced changes. Ice-wedge aggradation has dried out high centers of polygons and moistened polygon troughs for a millennia. Increased wetness encourages water-thriving plants such as *Arctophila fulva*, *Dupontia fisheri*, *Carex aquatilis*, and *Eriophorum angustifolium*. Increased dryness encourages plants needing less moisture such as *Puccinellia langeana*, *Festuca baffinensis*, *Trisetum spicatum*, *Dryas integrifolia*, and *Salix lanata* ssp. *Richardsonii* (McKendrick 2000b). These impacts would be mitigated and avoided by locating the road and pad on the highest portions of slopes where possible, and maintaining adequate cross-drainage by using culverts. Culverts would be maintained as needed to prevent ice-up.

Thermokarst is a localized thawing of ground ice resulting in a surficial depression and eventual erosion (Walker et al. 1987a). Thermokarst occurs naturally on the North Slope, contributing to the formation of frost polygon troughs, ponds, lakes, and other subsidence features. Surface disturbance that reduces the insulative value of vegetation and soil and/or landscape surface albedo (reflection) can lead to thermokarst because it enables the summer sun to thaw the soil to greater depths than usual (Truett and Kertell 1992). A study of road and culvert performance in Prudhoe Bay and Kuparuk showed that thin gravel roads (less than 5 feet) thaw completely, penetrating into the buried active layer. Thermokarst results in areas where this thaw exceeds the active layer (Brown et. al. 1984). Thick road berms and elevated pipelines would help prevent the melting of ground ice. However, in areas where there is a potential for a combination of surface disturbances from road dust, flooding, snowdrifts, and warming effects of the road, thermokarst may still occur (Walker et al. 1987a, Klinger et al. 1983b). Acceleration of thermokarst is probably initially due to the warming effects of impounded water adjacent to roads (Brown et. al. 1984). The loss of the moss layer from dust fallout may play a role in the development of roadside thermokarst. Vegetation cover, especially mosses, insulates permafrost from solar energy in the summer, and a decrease in vegetation cover may contribute to deepening of the permafrost thaw (Haag and Bliss 1974, Clymo and Hayward 1982). Generally, thermokarst of ice-rich tundra soil near the edges of gravel roads and pads may enhance plant productivity and species diversity because of increased thickness of the active layer and more available nutrients. An increase in the depth of the active layer may lead to an increase in graminoid and bryophyte production in wet habitats or a decrease in shrubs and lichens in moist or dry habitats (Hettinger 1992). Although, if the thermokarst expands and prolonged deep ponding or flooding results, adjacent vegetation communities may be lost completely (Walker et al. 1987b). At Prudhoe Bay, past practices resulted in thermokarst features that occur mostly within 80 feet of the road, but in some areas it can be seen at distances up to 330 feet (Walker et al. 1987b).

Indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst associated with roads, pads, and airstrips are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area of disturbance by vegetation classes and habitat types within this impact area.

The following operation measures would greatly reduce the amount of thermokarst from the levels associated with past practices: (1) summer watering of roads and conducting most transportation of equipment and materials during the winter to reduce impacts caused by dust; (2) proper culvert installation and annual maintenance would reduce impoundments and flooding impacts; and (3) the design of thick roads and elevated pipelines to reduce warming effects.

CROSS-DRAINAGE AND WATER FLOW

Although drainage plans, project design, culvert installation, and maintenance have helped prevent melting of the underlying permafrost and subsequent subsidence, gravel roads and pads may still intercept the natural flow of water, especially in drained thaw-lake basins, ephemeral streams, and floodplains. Impacts from cross-drainage and water flow would be greater in the Colville River Delta than in the National Petroleum Reserve-Alaska because the flow regimes are relatively more stable in the National Petroleum Reserve-Alaska and because ocean-induced storm surges would not occur near the proposed roads within the National Petroleum Reserve-Alaska. The disruption of sheet flow in the spring could dry up habitat on the downslope side of the roads and pads and cause the habitat on the upslope side to become wetter. These impacts would be avoided by locating the roads and pads on the highest portion of slopes where possible, and maintaining adequate cross drainage with culverts. Culverts would be maintained as needed to prevent ice-up. Bridges are also proposed for river and stream crossings and in all areas where a culvert or culvert batteries could not maintain the hydrologic regime.

AIR POLLUTION

Limited data is available on the sensitivity of arctic vegetation to air pollution. Previous studies have documented that plant life in general is affected by air pollution (Treshow and Anderson 1989, Unsworth 1982). Project construction would cause a localized and temporary impact on air quality. The sources of air pollution during the construction period would be fugitive dust from topsoil disturbance and gravel activities; exhaust from heavy construction equipment (earth movers, trucks, etc.) and drilling rigs; and emissions from electrical generators, portable light generators, small heaters, and similar temporary fuel burning equipment (PAI 2002). These sources are not expected to produce sufficient levels of pollutants to adversely affect vegetation. Studies at Prudhoe Bay have shown no consistent differences in cover of vascular plants and lichen in response to O_3, NO_2, NOx, and SO_2 deposition, although the levels encountered were not expected to be harmful to plants (Kohut et al. 1994). Conducting major construction activities in the winter when the topsoil is frozen and the ground would be covered with snow would minimize the generation of fugitive dust. Air quality impacts and applicable mitigation measures are discussed in Section 4A.2.3.2

PIPELINES

Beside the disturbance from ice roads and staging pads for the construction of pipelines (discussed above), the only other impact to vegetation from pipeline construction under Alternative A is from VSM borings. Given the maximum diameter of VSM borings and the projected number of VSMs to be constructed under Alternative A (presented in Section 2), and adding a 0.5-foot disturbance buffer to account for potential spoils and thermal impacts around the borings, about 0.5 acre of vegetation would be lost to VSM installation. The vegetation and habitat types affected would depend on the exact location of the VSM. An elevated pipeline design reduces impacts to vegetation and habitat types compared to buried pipeline designs.

POWER LINES

Power line design (suspended between CD-6 and CD-7 and on cable trays mounted on pipeline VSMs elsewhere) would reduce the effects of power lines on vegetation and habitats. Given the maximum pole diameter and the projected number of poles to be placed under Alternative A (presented in Section 2), and adding a 0.5-foot disturbance buffer to account for potential spoils and thermal impacts around the poles, approximately 670 square feet of vegetation would be lost from pole placement for the suspended power line between CD-6 and CD-7.

OPERATION PERIOD

The operation period includes continued drilling and day-to-day operations and maintenance once production has begun.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Additional vegetation losses following construction could occur during the operational period during maintenance of gravel roads (such as snow removal) or if flood events wash out portions of roads or pads and deposit gravel on tundra.

Gravel that is inadvertently spread or sprayed on areas adjacent to roads and pads also affects vegetation. Impacts depend on site-specific conditions and the amount of gravel on tundra. Gravel spray that simply adds a scattering of stones to the tundra often stimulates the growth of vegetation, probably because of soil warming with the gravel cover, which increases the decomposition of organic matter and releases nutrients (McKendrick 2000b). The response may not appear for several years following disturbance and may persist for only a few years. Increasing thickness of gravel may kill plants; the prostrate and low-stature forms would be killed first. If gravel accumulates gradually in wet sedge meadows dominated by rhizomatous sedges, vegetation may persist even after the gravel has become 10 to 20 inches thick. The indigenous grasses and sedges keep pace with the buildup, rooting at stem bases and producing rhizomes at higher levels as the gravel thickness increases. But even in wet environments, 4 to 8 inches of gravel deposited at once may kill all plants, and recovery must occur either by invasion from the gravel margins or by seedling establishment (McKendrick 2000b). Effects of flood event washouts on vegetation would depend on site-specific conditions and the amount of gravel washed out onto tundra, but would be similar in type to the impacts described above. Vegetation in disturbed drier sites would not be able to compensate with vegetation growth, but many plants are adapted to colonize gravel areas by seeds. Impacts to vegetation from gravel and fill spreading would be mitigated by slope stabilization using revetments or soil binders (including road watering).

DUST FALLOUT FROM ROADS

During the operation period, effects of dust from roads, pads and airstrips are expected to be realized within the 164-foot impact zone. The effects of dust on vegetation are described in the Construction Period section above. Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area of disturbance by vegetation and habitat types within this impact area.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

In addition to ice roads required for construction-related activities, approximately 64 miles of ice roads would be needed for facility operations including well workovers and drilling activities at remote sites such as CD-3, resulting in approximately 310 acres of vegetation disturbed over the life of the facility. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year. Ice pads would not likely be needed during operations. See the Construction Period discussion above for potential impacts.

As during the construction period, snowdrifts or plowed snow would accumulate on tundra adjacent to roads, well pads, and airstrips. Impacts would be similar to those discussed above in the Construction Period section.

OFF-ROAD TUNDRA TRAVEL

Some off-road tundra travel would continue during the operational period to respond to spills or other emergencies, to conduct pipeline maintenance and repair, to facilitate ice road construction, or to transport supplies and equipment to roadless development sites. See the Construction Period discussion above for potential impacts.

IMPOUNDMENTS AND THERMOKARST

Although there is a potential for some habitat loss and alteration to occur from thermokarst and the creation of impoundments during the operational period of the project, these impacts are more likely to be initiated during construction. Therefore, the factors causing vegetation loss and alteration are discussed above in the Construction Period section.

CROSS-DRAINAGE AND WATER FLOW

Disruption of cross-drainage and interception of sheet flow would continue to cause impacts to vegetation during the operational phase of this project. These impacts are initiated during the construction period and are discussed above.

AIR POLLUTION

Air pollution levels would increase during operations with the ACX upgrade of the existing APF-1 and increased emissions from traffic, drilling equipment, and well servicing and production equipment. However, this increase is not expected to generate levels of pollutants that would adversely affect vegetation. Air quality impacts resulting from emissions from well servicing and drilling equipment would be intermittent and localized. Air quality impacts and applicable mitigation measures are discussed in Section 4A.2.3.2.

Air quality monitoring and modeling data associated with the Central Compressor Plant (CCP), which has the greatest air emissions of any facility at Prudhoe Bay, showed that pollutant levels were not of sufficient concentration (in both long-term averages and maximum values) to represent a hazard to vegetation (Kohut et al. 1994). The vascular and lichen plant communities monitored during the Prudhoe Bay research did not reveal any changes in species composition that could be related to differences in exposure to pollutants, and no symptoms similar to those caused by air pollutants were observed on any of the plants examined. A pattern of change in the rates of photosynthesis along the dispersion gradient was detected in one year but did not appear to be directly related to changes in levels of foliar nitrogen. Laboratory tests were conducted during this same study to assess the effects of air pollution on plant physiology of selected species (*Eriophorum angustifolium* and *Salix arctica*). These species were found to be unaffected by acute exposure to NO_2 and NO_x (Kohut et al. 1994). The conclusions of this study, however, do not represent an assessment of potential impacts on vegetation from chronic, long-term exposure to air pollutant emissions impacts on the North Slope.

PIPELINES

Pipeline operation would not cause vegetation losses or alteration. However, occasional large-scale pipe repairs that may be required during the thawed season could result in additional damage to tundra from equipment needed to conduct the repair work. Tundra travel is discussed above. Additionally, indirect impacts (discussed above in the Construction Period section) associated with snow drifting and shading would continue to occur during the operational period. Effects of pipeline spills on tundra are described in Section 4.3.

POWER LINES

No additional impacts on vegetation would occur from power lines during the operational period.

ABANDONMENT AND REHABILITATION

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantlement of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill is removed; less if it remains in place. If roads and pads are left in place, and especially if cross drainage across roads is not maintained, impoundment will occur and could alter plant communities as described in the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation is covered with washed-out gravel. Roads and pads, if left in place would likely be required to be revegetated with plants native to gravel bars and ridges in the Arctic, i.e., different from the plant communities surrounding the proposed CPAI facilities. (Kidd et al. 2004) Revegetation activities may occur over several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and the CD-3 airstrip may be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, though this can take many years (more than a decade) and because thaw subsidence is difficult to predict, complete restoration to preexisting conditions is improbable (Kidd et al. 2004).

4A.3.1.2 Alternative A – Full-Field Development Scenario Impacts on Terrestrial Vegetation and Wetlands

Because the exact placement of FFD project components are unknown, the impact area for vegetation classes was assumed to be proportional to the distribution of vegetation classes within the circles surrounding each FFD facility for pads and airstrips (Figure 2.2.3-1) and within a 1-mile buffer around FFD roads. Habitat types were not assessed for FFD because habitat mapping does not cover the entire Plan Area (Figure 3.3.1.3-1) (Jorgenson et al. 2003c). Vegetation impacts due to gravel placement for pads and airstrips within the FFD circles were based on ABR, Inc. or BLM and DU mapping on Figure 3.3.1.2-1 (Jorgenson et al. 1997, 2003c, BLM and DU 2002). Acreages of each vegetation class within FFD circles were calculated and summed by Group. (Colville River Delta Facility Group, Fish-Judy Creeks Facility Group, and Kalikpik-Kogru Rivers Facility Group). Total acreage of each vegetation class was then converted to a proportion of the total area within the circles in each Group. Direct impact acreages were estimated using Tables 2.4.1-6, 2.4.1-7, 2.4.3-7, 2.4.4-8, and 2.4.4-11.. Indirect impact acreages were estimated using standard footprints of gravel facilities (well pads, airstrips, airstrip aprons, helipads, and storage pads) and calculating the impact area within a 164-foot (50-meter) area around these facilities using GIS. The area of each vegetation class that would be impacted was estimated based on the total impact area multiplied by the proportion of each vegetation class within each Group. Because FFD roads do not fall within the FFD circles (Figures 2.4.1.2-1, 2.4.2.2-1, and 2.4.4-2), a 1-mile wide buffer around FFD roads was overlain on the vegetation map (Figure 3.3.1.2-1). Acreages of each vegetation class within the 1-mile buffer were calculated and summed by Group. The acreage of each vegetation class by Group was then converted to a proportion of the total area within the buffer. Direct impact acreages for roads by Group were estimated using the length of FFD roads within each Group and a standard toe-to-toe road width of 54 feet. Indirect impact acreages by Group were estimated using the length of FFD roads within each Group and calculating the area using a 164-foot (50-meter) impact width on both sides of the road. The area of each vegetation class that would be directly or indirectly impacted by FFD roads was then estimated based on the total impact acreages and the proportions of each vegetation class by Group. Summaries of these FFD analyses are presented in Tables 4A.3.1-3, 4A.3.1-4, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-3, 4C-1.3.1-4, 4D.3.1-5, and 4D.3.1-6.

Under the Alternative A FFD scenario, direct and indirect impacts to vegetation related to gravel fill; dust fallout from roads; ice roads and snow stockpiles; impoundments and thermokarst; cross-drainage and water flow; air pollution; pipelines; and oil and brine spills in the three facility group areas would be the same types as those described under CPAI Development Plan Alternative A. In addition to the impacts of the CPAI Development Plan, under the FFD scenario for Alternative A approximately 1,262 acres of tundra vegetation would be covered with gravel fill for the construction of pads (well pads, APF pads, and storage pads), airstrips and associated aprons (462 acres), and approximately 122 miles of roads (800 acres). Approximately 5,662 acres of vegetation would be indirectly impacted by dust, gravel spray, snowdrifts, impoundments, and thermokarst. Tables 4A.3.1-3 and 4A.3.1-4 summarize the areas of vegetation classes affected under Alternative A – FFD Scenario . The effects of FFD on terrestrial vegetation and wetlands would depend on the location and extent of development in specific locations within each facility group area.

COLVILLE RIVER DELTA FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 216 acres of vegetation would be lost in the Colville River Delta Facility Group under Alternative A – FFD Scenario for the construction of pads (hypothetical production pads HP-4, 5, 7, 8, 12, 13, and 14 and storage pads) and airstrips (164 acres) and connecting roads (52 acres) (Table 4A.3.1-3 and Table 4A.3.1-4). The dominant vegetation class in the vicinity of the Colville River Delta is Wet Sedge Meadow Tundra. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described above under the CPAI Development Plan Alternative A.

Gravel extraction for the hypothetical FFD would result in the destruction of approximately 346 acres of tundra vegetation. Specific gravel sources for the hypothetical FFD scenario have not been identified. The development process for any future gravel source would include planning, design, permitting, temporary staging areas, removal of overburden, blasting and excavation of gravel, and an approved rehabilitation plan. Analysis of impacts and appropriate mitigation measures would be examined before approval of future mine sites.

DUST FALLOUT FROM ROADS

Under Alternative A – FFD Scenario , indirect impacts, including dust impacts, are expected to occur within 164 feet (50 meters) of gravel facilities as described above, resulting in alteration of about 651 acres of tundra vegetation in the Colville River Delta Facility Group (Tables 4A.3.1-3 and 4A.3.1-4). The types of impacts to vegetation from dust fallout and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative A – FFD Scenario in the Colville River Delta Facility Group, approximately 155 miles of temporary ice roads would be constructed over the life of the project, affecting approximately 752 acres of vegetation. The maximum area in the Colville River Delta Facility Group covered by ice roads in a single year would be 165 acres, with an average of 125 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the increased length of pipeline, roads, and number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. Indirect impacts from dust and changes to moisture or thermal regimes under Alternative A – FFD Scenario are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation class within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with disruption of cross-drainage and interception of sheet flow would be the same as those described previously for CPAI Development Plan Alternative A. These impacts would be greatest in the vicinity of the Colville River Delta because of unstable flow regimes and ocean-induced storm surges. In addition, roads would likely cross many ephemeral streams in the Colville River Delta area, and culverts would need to be installed. Gravel placement could potentially disturb sheet flow in the spring and could affect local moisture regimes. Culverts allow surface water flow, but they tend to ice-up and increase flow in a small area compared to typical sheet flow. Alteration of sediment deposition patterns during flood events may occur due to obstructions from roads and redirection of flood waters through culverts. These changes may result in alteration of vegetation succession and long-term alteration of habitat types.

AIR POLLUTION

No additional processing facilities would be built in the Colville River Delta area under Alternative A. However, the increased number of vehicles and equipment associated with the production pads and roads in FFD would potentially cause more air pollution. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

In addition to the impacts from the CPAI Development Plan Alternative A, a total of approximately 2 acres of vegetation would be lost to VSM installation under the Alternative A FFD scenario, of which approximately 0.4 acre would occur in the Colville River Delta Facility Group. The vegetation and habitat types affected would depend on the exact location of the VSM, which are generally spaced at 55 to 65 foot intervals. The types of impacts to vegetation associated with snow drifting or shading from the aboveground pipelines would be the same as those described above under the CPAI Development Plan Alternative A.

POWER LINES

Under Alternative A – FFD Scenario , power lines would be on pipeline VSMs and would not cause any additional disturbance to vegetation.

FISH-JUDY CREEKS FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 711 acres of vegetation would be lost in the Fish-Judy Creeks Facility Group under Alternative A – FFD Scenario for the construction of pads (a processing facility; production pads HP-1, 2, 3, 6, 9, 10, 11, 15, 16, 17, and 19; and storage pads), airstrips (166 acres), and connecting roads (545 acres) (Tables 4A.3.1-3 and 4A.3.1-4). Dominant vegetation classes in the Fish-Judy Creeks Facility Group are *Dryas* Tundra and Wet Sedge Meadow Tundra. The types of disturbances and effects on vegetation associated with gravel fill placement would be the same as those described above under the CPAI Development Plan Alternative A.

DUST FALLOUT FROM ROADS

In the Fish-Judy Creeks Facility Group, indirect impacts from dust, gravel spray, snowdrifts, impoundments, and thermokarst would alter approximately 3,577 acres of vegetation (Tables 4A.3.1-3 and 4A.3.1-4). The types of disturbances and effects on vegetation would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, approximately 209 miles of ice roads would be built over the life of the project, affecting about 1,013 acres of vegetation. The maximum area covered by ice roads in a single year would be 170 acres, with an average of 101 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the longer pipeline and roads and the number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. The construction of more roads and pads would result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation type within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described above under the CPAI Development Plan Alternative A, although the construction of more roads and culverts would cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Fish-Judy Creek Facility Group would result in a localized increase of air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

In the FFD scenario of Alternative A, VSM placement would cause the loss of approximately 1.1 acres of vegetation in the vicinity of the Fish-Judy Creeks Facility Group.

POWER LINES

Power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

TABLE 4A.3.1-3 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM PADS, AIRSTRIPS, APRONS, AND STORAGE PADS

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)
Riverine Complex	0	(0.0%)	0.0	0.0	30	(0.1%)	0.1	0.2	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	56	(0.3%)	0.4	0.9	278	(0.6%)	1.0	1.7	49	(0.3%)	0.4	0.6
Fresh Sedge Marsh	3	(0.0%)	0.02	0.05	3,343	(7.5%)	12.4	19.9	1,483	(8.8%)	11.7	18.1
Deep Polygon Complex	550	(2.6%)	4.2	8.5	4,833	(10.9%)	18.0	28.8	1,493	(8.9%)	11.8	18.3
Young Basin Wetland Complex	0	(0.0%)	0.0	0.0	2,013	(4.5%)	7.5	12.0	721	(4.3%)	5.7	8.8
Old Basin Wetland Complex	0	(0.0%)	0.0	0.0	1,261	(2.8%)	4.7	7.5	0	(0.0%)	0.0	0.0
Wet Sedge Meadow Tundra	9,494	(44.1%)	72.2	147.2	9,856	(22.1%)	36.7	58.6	6,533	(39.0%)	51.5	79.9
Salt-killed Wet Meadow	1,633	(7.6%)	12.4	25.3	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	1,210	(5.6%)	9.2	18.8	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	32	(0.1%)	0.2	0.5	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Shrub Tundra	782	(3.6%)	5.9	12.1	4,318	(9.7%)	16.1	25.7	0	(0.0%)	0.0	0.0
Tussock Tundra	139	(0.6%)	1.1	2.2	14,936	(33.5%)	55.6	88.9	5,452	(32.5%)	43.0	66.7
Dryas Dwarf Shrub Tundra	29	(0.1%)	0.2	0.5	238	(0.5%)	0.9	1.4	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	395	(0.9%)	1.5	2.4	284	(1.7%)	2.2	3.5
Halophytic Willow Dwarf Shrub Tundra	8	(0.0%)	0.1	0.1	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	1,929	(9.0%)	14.7	29.9	520	(1.2%)	1.9	3.1	1	(0.0%)	<0.1	<0.1
Open and Closed Tall Willow Shrub	0	(0.0%)	0.0	0.0	172	(0.4%)	0.6	1.0	0	(0.0%)	0.0	0.0
Dune Complex	0	(0.0%)	0.0	0.0	902	(2.0%)	3.4	5.4	185	(1.1%)	1.5	2.3

TABLE 4A.3.1-3 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM PADS, AIRSTRIPS, APRONS, AND STORAGE PADS (CONT'D)

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)
Partially Vegetated	1,183	(5.5%)	9.0	18.4	412	(0.9%)	1.5	2.5	154	(0.9%)	1.2	1.9
Barrens	4,487	(20.8%)	34.1	69.6	1,030	(2.3%)	3.8	6.1	411	(2.5%)	3.2	5.0
Totals	**21,536**	**(100.0%)**	**163.7**	**334.0**	**44,537**	**(100.0%)**	**165.8**	**265.0**	**16,768**	**(100.0%)**	**132.1**	**205.0**

Notes:
Calculation methods are described in text in Section 4A.3.1.2.
Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

TABLE 4A.3.1-4 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM ROADS

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)
Riverine Complex	12	(0.5%)	0.3	1.6	65	(0.2%)	1.0	5.9	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	12	(0.5%)	0.3	1.6	1,463	(4.0%)	21.9	133.0	1	(16.2%)	32.8	199.5
Fresh Sedge Marsh	0	(0.0%)	0.0	0.0	363	(1.0%)	5.4	33.0	0	(0.0%)	0.0	0.0
Deep Polygon Complex	11	(0.4%)	0.2	1.4	54	(0.1%)	0.8	4.9	0	(0.0%)	0.0	0.0
Young Basin Wetland Complex	43	(1.7%)	0.9	5.4	3,206	(8.8%)	48.0	291.5	0.47	(6.8%)	13.7	83.3
Old Basin Wetland Complex	73	(2.9%)	1.5	9.3	1,413	(3.9%)	21.2	128.5	0	(0.0%)	0.0	0.0
Wet Sedge Meadow Tundra	935	(37.7%)	19.7	119.4	6,584	(18.1%)	98.6	598.7	1	(12.4%)	25.1	152.5
Salt-killed Wet Meadow	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	3	(0.1%)	0.1	0.4	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Shrub Tundra	348	(14.0%)	7.3	44.4	4,387	(12.0%)	65.7	399.0	0	(0.0%)	0.0	0.0
Tussock Tundra	321	(12.9%)	6.8	41.0	8,766	(24.1%)	131.2	797.1	4	(53.7%)	108.6	659.4
Dryas Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	95	(0.3%)	1.4	8.6	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	231	(9.3%)	4.9	29.5	8,488	(23.3%)	127.1	771.8	0.45	(6.5%)	13.2	80.0
Halophytic Willow Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	277	(11.2%)	5.8	35.4	842	(2.3%)	12.6	76.6	0.14	(2.0%)	4.1	25.2
Open and Closed Tall Willow Shrub	0	(0.0%)	<0.1	<0.1	78	(0.2%)	1.2	7.1	0	(0.0%)	0.0	0.0
Dune Complex	0	(0.0%)	0.0	0.0	232	(0.6%)	3.5	21.1	0	(0.0%)	0.0	0.0

TABLE 4A.3.1-4 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM ROADS (CONT'D)

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)
Partially Vegetated	65	(2.6%)	1.4	8.3	131	(0.4%)	2.0	12.0	0	(0.0%)	0.0	0.0
Barrens	151	(6.1%)	3.2	19.2	259	(0.7%)	3.9	23.5	0.16	(2.4%)	4.8	29.2
Totals	**2,482**	**(100.0%)**	**52.2**	**316.9**	**36,426**	**(100.0%)**	**545.3**	**3,312.3**	**6.95**	**(100.0%)**	**202.3**	**1,229.1**

Notes:
Calculation methods are described in text in Section 4A.3.1.2.
Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 334 acres of vegetation would be lost in the Kalikpik-Kogru Rivers Facility Group for the construction of pads (a processing facility; production pads HP-18, 20, 21, and 22; and storage pads),airstrips (132 acres), and connecting roads (202 acres) (Tables 4A.3.1-3 and 4A.3.1-4). The dominant vegetation classes in this portion of the Plan Area are Tussock Tundra and Sedge/Grass Meadow. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described above under CPAI's Development Plan Alternative A.

DUST FALLOUT FROM ROADS

The Kalikpik-Kogru Rivers Facility Group could result in indirect impacts from dust, gravel spray, snowdrifts, impoundments, and thermokarst potentially altering approximately 1,434 acres of vegetation (Tables 4A.3.1-3 and 4A.3.1-4). The types of disturbances and effects on vegetation would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Alternative A – FFD Scenario area would result in approximately 167 miles of ice roads being built during construction and over the life of the project, affecting about 810 acres of vegetation. The maximum area covered by ice roads in a single year would be 252 acres, with an average of 203 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the increased length of pipeline and roads and the number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. The construction of more roads and pads would result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation type within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described above under the CPAI Development Alternative A, although the construction of more roads and culverts would cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Kalikpik-Kogru Rivers Facility Group would result in a localized increase in air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

Under the FFD scenario for Alternative A, VSM placement would cause the loss of approximately 0.6 acre of vegetation in the vicinity of the Kalikpik-Kogru Rivers Facility Group. The types of impacts to vegetation associated with snow drifting or shading from pipeline placement would be the same as those described above under CPAI's Development Plan Alternative A.

POWER LINES

Power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

4A.3.1.3 Alternative A – Summary of Impacts (CPAI and FFD) on Terrestrial Vegetation and Wetlands

Impacts from the CPAI Development Plan Alternative A to vegetation and habitat types are summarized in Tables 4A.3.1-1 and 4A.3.1-2, respectively. Impacts from Alternative A – FFD Scenario are summarized in Tables 4A.3.1-3 and 4A.3.1-4.

Vegetation maps cover the entire Plan Area, and detailed wildlife habitat maps are available for the entire area affected by CPAI's proposed Alternative A (Figure 4A.3.1-2). Vegetation types and wildlife habitat types are cross-referenced in Table 3.3.1-3. Summary of impacts are presented as percentages of available vegetation type or habitat class within the Colville River Delta or the National Petroleum Reserve-Alaska portions of the Plan Area. Wildlife habitat mapping covers 100 % of the Colville River Delta, 24 % of the National Petroleum Reserve-Alaska portion of the Plan Area, and 37 % of the total Plan Area.

Under CPAI Alternative A, approximately 306 acres of tundra vegetation would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 2,968 acres would be altered or disturbed by ice roads and pads, dust, and changes to thermal or moisture regimes; combined representing less than one % of the Plan Area (Tables 4A.3.1-1 and 4A.3.1-2).

In the Colville River Delta portion of the Plan Area, the highest surface area impacts are to Wet Sedge Meadow vegetation (211 acres lost or altered; 0.5 % of what is available in the area) and Patterned Wet Meadow habitat (150 acres lost or altered; 0.5 % of what is available in the area). In the National Petroleum Reserve-Alaska portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (581 acres lost or altered; 0.3 % of what is available in the area) and Moist Tussock Tundra habitat (581 acres lost or altered; 1.2 % of available mapped habitat in the area) (Tables 4A.3.1-1 and 4A.3.1-2).

Under Alternative A – CPAI, key wetland habitats that would be lost or altered in the 146,637 acre Colville River Delta are: riparian shrubland (34 of 7,575 acres); aquatic grass marsh (1.6 of 369 acres); deep open lakes (9.4 of 7,810 acres); basin-complex wetlands (0 of 2 acres); and coastal wetlands (less than 0.1 of 29,022 acres). Key wetland habitats that would be lost or altered in the 175,153 acres mapped in the National Petroleum Reserve-Alaska portion of the ASDP Plan Area are: riparian shrubland (6.0 of 4,741 acres); aquatic grass marsh (0 of 501 acres); deep open lakes (1.2 of 22,374 acres); basin-complex wetlands (62 of 16,297 acres); and coastal wetlands (0 of 36 acres). Thus impacts to all key wetlands, including those that contain *Arctophila* and *Carex aquatilis*, will be minor.

Under Alternative A – FFD, approximately 1,608 acres of tundra vegetation (less than one % of the Plan Area) would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 8,237 acres (less than one % of the Plan Area) would be altered or disturbed by ice roads, dust, snowdrifts and changes to thermal or moisture regimes (Tables 4A.3.1-3 and 4A.3.1-4). Habitat types were not assessed for FFD because habitat mapping does not cover the entire Plan Area (Figure 3.3.1.3-1) (Jorgenson et al. 2003c).

4A.3.1.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Terrestrial Vegetation and Wetlands

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and Alternative A – FFD Scenario .

GRAVEL PADS, ROADS, AND AIRSTRIPS

- Fill slopes would be stabilized by revetments or soil binders where necessary.
- Impoundments and thermokarst impacts would be mitigated and avoided by locating the road and pad on the highest portions of slopes where possible, and maintaining adequate cross-drainage by using culverts. Culverts would be maintained as needed to prevent ice-up.
- Apply sealing agents, chip seal, and water to dust prone areas.

DUST FALLOUT FROM ROADS

Impacts from dust would be reduced by scheduling construction and associated traffic in the winter when dust from the road would be less, and watering roads during the summer (a standard North Slope practice) to keep dust down and maintain road bed integrity. Chip seal could also be used to minimize impacts to vegetation from road dust.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

- The most direct ice road route across the least sensitive habitat types would be taken to minimize disturbance.
- Ice road routes would have slight variations yearly to avoid multi-year impacts to the same alignment.
- Shrub areas would be avoided where possible.

OFF-ROAD TUNDRA TRAVEL

- The numbers of vehicle passes in an area would be limited.
- Tight turns would be avoided.

4A.3.1.5 Alternative A – Effectiveness of Protective Measures for Terrestrial Vegetation and Wetlands

Stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS will reduce impacts to terrestrial vegetation and wetlands. Stipulation 18 requires ice roads to be offset to reduce vegetative impacts. Stipulation 22 prohibits the clearing of willows in riparian zones. Stipulations 24 f, g, h, i, and l are designed to protect vegetation by requiring low pressure vehicles, limiting bulldozing, limiting the number of trips over the same area, insuring proper snow frost depths, and eliminating tight turns by tracked vehicles. Stipulation 46 protects wetland areas by avoiding the siting of facilities in key wetlands areas. In addition to these stipulations, mitigation developed in this EIS will reduce salinity concerns from gravel fill, and help stabilize fill slopes.

4A.3.2 Fish

The CPAI Development Plan Alternative A (Figure 2.4.1.1-1) involves constructing and operating a network of production pads, roads, pipelines and an airstrip to produce hydrocarbon reserves in the Colville River Delta and Fish Creek drainage. Within the Plan Area, the primary concern for fish is maintaining adequate winter habitat, which is the most crucial habitat to arctic fish (see Section 3.3.2). Other high priorities are maintaining suitable feeding and spawning areas and the ability to access these areas, which are often in different geographic locations (e.g., broad whitefish spawn in river channels whereas drainage and frequent flooding of perched lakes provide overwintering and rearing areas). Key issues on fish habitats and populations include the effects of water withdrawal; alteration of flow patterns; release of contaminants during the life of the project; alteration to water quality, especially during winter; and the impacts of oil spills. Special consideration should be given to certain crucial locations and habitats within the Plan Area (see Section 3.3.2.2).

Impacts of, and measures to prevent, control, and mitigate spills are not addressed in this section, but are discussed in Section 4.3. Further, that section includes an assessment of the project effects on marine fish and habitats. Normal construction and operation impacts for this alternative would not be expected to have measurable impacts on Harrison Bay and nearshore Beaufort Sea environments and biota. Most impacts are to freshwater and migratory species and impacts will be similar on all freshwater and migratory species.

4A.3.2.1 Alternative A – CPAI Development Plan Impacts on Fish

CONSTRUCTION PERIOD

Roads, airstrips, pipelines, and pads would be constructed during winter, and well drilling operations could occur year-round. If construction were to occur in high-density spawning or overwintering areas, or during summer in migratory corridors, it could affect a relatively large number of freshwater and migratory fish. Potential impacts of construction under those conditions would include degradation or loss of overwintering habitat, partially blocked access to and from summer feeding and wintering areas, and siltation in or near these habitats. The scope of such impacts may be quite variable but could result in spawning failure and/or unacceptable levels of fish mortality.

However, pad and road construction is likely to have no measurable adverse effect on arctic fish populations in general because construction is scheduled to occur in winter mostly in low-diversity areas (the Ublutuoch River is an exception) that are sparsely inhabited by large fish and not during times when migratory fish are moving through these habitats. Further, construction has been designed to minimize siltation effects and impacts on fish passage. Pad and road construction may impact some of the smaller resident fish (such as ninespine stickleback), but most fishes are likely to move into other areas during construction. Thus the overall effects are considered insignificant.

WATER WITHDRAWAL

The main potential effect of construction on fish would be from water withdrawal to support construction of drill pads, roads, and airstrips. Water would be needed for building ice roads along the proposed pipeline route, ice pads, and for camp operations. In addition to water withdrawal, CPAI will use frozen lakes for ice chips.

Water removal from lakes could potentially affect fish populations. Water removal is especially critical in late winter. Deep-water lakes provide important habitat for overwintering fish. Construction typically begins in December or January when ice thickness is around 4 feet, with ice growth continuing through the winter construction period. By late in the Arctic winter, fresh water may freeze 6 to 7 feet deep, eliminating all free water in shallow lakes and ponds and greatly reducing the unfrozen areas of deeper lakes. Lakes that are deeper than 4 feet are often suitable for water withdrawals early in the season, and thus lakes 5 to 6 feet can provide substantial volumes of water. Those lakes deep enough to permit under-ice withdrawals throughout the winter are also likely to support overwintering fish (Figure 4A.3.2-1). Bacterial respiration in decomposing lake sediments outstrips the limited oxygen production of algae and other plants. If dissolved oxygen depletion is too severe, fish are not able to survive. Consequently, it is important to protect the habitat that deeper lakes provide.

Excessive winter water withdrawal from lakes with water levels that are barely to moderately sufficient to support overwintering fish may further reduce the oxygen pool and potentially eliminate fish populations. Figure 3.3.2.2-1 shows the distribution of fish in the Plan Area lakes based on their sensitivity to habitat changes likely to be associated with project activities (e.g., water withdrawal).

The ADNR, Division of Mining Land and Water, Water Resources Section is the regulatory entity that approves water withdrawals from any surface and subsurface water bodies such as those that may be utilized by the proposed project: the ADNR, Office of Habitat Management and Permitting also has authority over water withdrawals from water bodies containing fish (Table 1.1.4-1). Table 4A.3.2.1 summarizes the fish presence and water available in lakes that CPAI has permitted for winter withdrawal. Other permitted lakes may also be used as water sources, and CPAI may request permits for additional lakes.

In the CD-3 area, 18 lakes have been identified as potential sources of winter water for ice road construction and other uses (Figure 4A.3.2-1 and Table 4A.3.2-1). Of these, 11 contain fish populations (Table 4A.3.2-1), and water withdrawal would thus be restricted.

In the CD-4 area, a total of six lakes have been identified as potential freshwater sources, with perched lakes L9323 and L9324 planned to be used for that purpose (Figure 4A.3.2-1 and Table 4A.3.2-1). All have low specific conductance (that is, they are freshwater lakes), and all have been confirmed as fish overwintering sites.

According to Figure 4A.3.2-1, two lakes in the vicinity of CD-5 (L9601 and N77097)(Figure 4A.3.2-1) have been permitted for water use. Lake L9601 is less than 2.5 feet deep and would ultimately freeze to the bottom by mid-winter (Table 4A.3.2-1); thus there will be no fish present, and there will be no impacts to fish due to winter water withdrawal. Lake N77097 (Oil Lake) is less than 7 feet deep (approximately 6 feet at deepest [Bill Morris 2004, pers. comm.]), and ninespine stickleback are found there (Table 4A.3.2-1). Lake N77097 probably does not freeze to the bottom during most winters. This is because its surface area is nearly 900 acres, and thus the lake has a fairly high thermal mass, and because bottom substrates produce some heat well into winter, thus inhibiting freezing of bottom water. Should the lake freeze in a particularly severe winter, ninespine stickleback from nearby lakes could recolonize the lake at break-up (Bill Morris 2004, pers. comm.).

Four lakes in the vicinity of the CD-6 production pad have been permitted for water use (Figure 4A.3.2-1 and Table 4A.3.2-1). Of these, Lake MC7917 is by far the largest and is known to support least cisco. A total of 12.4 million gallons of water can safely be removed from this lake, according to current ADNR permit criteria.

Thirteen lakes in the CD-7 area have been permitted for water use (Figure 4A.3.2-1 and Table 4A.3.2-1). Two of these have been reported to contain fish species that are not resistant to low dissolved oxygen concentrations that may result from water withdrawal (Figure 3.3.2.2-1): Arctic grayling (Moulton 2000, 2002) and least cisco (Moulton 2002) were reported from Lake M9910; and Lake M9914 was reported to have contained Arctic grayling (Moulton 2003, unpublished).

The BLM currently authorizes unlimited winter water withdrawals from any lake if it can be demonstrated that no fish inhabit the lake. Water withdrawals from fish-bearing lakes 7 feet or deeper is limited to 15 % of estimated under-ice free-water volume. Water withdrawals of up to 30 percent of under-ice free-water volume would be permitted from lakes with depths between 5 and 7 feet that contain only ninespine stickleback and/or Alaska blackfish. Removal of grounded ice would be permitted from lakes on a site-specific basis with the removed ice aggregate being included in the 15 or 30 percent limit, whichever is appropriate. Unlimited water may be withdrawn from any lake less than 5 feet in depth since it would freeze to the bottom during winter anyway and kill the resident fish.

TABLE 4A.3.2-1 SUMMARY OF FISH PRESENCE AND ESTIMATED AVAILABLE WINTER WATER IN LAKES IN THE CD-3, CD-4, CD-5, CD-6, AND CD-7 AREAS

Lake (see Figure 4A.3.2-1)	GIS Est. Acreage	Max Depth (feet)	Calculated Volume (mil gals)	15% Vol. >7 feet (mil gals)	Specific Conductance (µS/cm)	TDS (mg/L)	Volume Available (mil gals)	Fish Confirmed (codes below)
CD-3 Area								
M9713	14.5	11.0	17.3	0.1	3,302	1,640	17.3	No
M9712	52.5	8.1	46.2	0.0	3,767	2,180	46.2	No
M9313	140.2	25.1	415.1	19	764	370	19	LSCS
M0019	5.4	10.8	6.3	0.0	584	296	6.3	No
L9903	8.3	22.9	20.7	1.0	836	486	1.0	LSCS
L9905	7.4	12.4	10.0	0.1	5,860	3,470	10.0	No
L9904	12.5	25.3	34.4	2.0	622	354	2.0	BDWF, LSCS
L9210	134.7	29.1	452.4	28.2	281	200	28.2	LSCS
L9908	9.5	11.3	11.7	0.1	251	130	11.7	No
L9906	14.7	13.0	20.8	0.3	416	238	0.3	BDWF, LSCS
L9108	112.2	17.1	208.4	6.4	1,867	800	6.4	LSCS
L9907	11.2	10.1	12.3	0.1	1,405	128	12.3	No
M9709	64.6	18.9	132.5	5.0	302	4,254	5.0	LSCS
M9626	20.1	20.3	44.3	1.9	246	144	1.9	LSCS
M9522	19.9	9.0	19.5	0.0	4,290	2,482	19.5	No
L9281	43.8	13.5	64.2	1.1	346	202	1.1	BKFH, LSCS, NSSB
M9321	20.8	11.7	26.4	0.3	146	88	0.3	LSCS, NSSB
L9279	19.1	12.7	26.3	0.4	193	190	0.4	NSSB
CD-4 Area								
L9323	84.1	23.2	199.0	5.4	70	53	5.4	BDWF, BKFH, HBWF, LSCS, NSSB, RDWF, SLSC
L9324	126.1	13.0	231.6	1.2	60	95	1.2	ARCS, BDWF, BKFH, CHUM, DCHAR, GRAY, HBWF, LAMP, LNSK, LSCS, NSSB, RDWF
L9325	32.5	17.3	61.1	1.9	102	--	1.9	ns
M9524	147.2	17.6	352.0	7.7	115	--	7.7	ARCS, FHSC, HBWF, LSCS, NSSB
M9525	103.6	8.2	92.2	0.04	348	--	0.04	ARCS, BDWF, HBWF, LSCS, NSSB, RDWF
M9929	11.5	13.8	17.3	0.3	108	52	0.3	LSCS
CD-5 Area								
L9601	54.9	2.5	14.9	--	--	--		ns
N77097	869.8	6.0	566.9	--	200	--		NSSB
CD-6 Area								
M9912	34.8*	9.6*	61.9*	--	97*	55*	62	No
M9913	20.0	7.9	29.8*	0.02*	86	74*	?	No*
M9924	47.9	3.4	17.7	--	217	194		NSSB
MC7917	312.5	12.9	605.9	12	--	48	12	LSCS
CD-7 Area								
M0022	38.0	6.5	26.8	--	96	84	27	No
M0023	16.4	3.9	6.9	--	192	128	7	No

Table 4A.3.2-1 Summary of Fish Presence and Estimated Available Winter Water in Lakes in the CD-3, CD-4, CD-5, CD-6, and CD-7 Areas (Cont'd)

Lake (see Figure 4A.3.2-1)	GIS Est. Acreage	Max Depth (feet)	Calculated Volume (mil gals)	15% Vol. >7 feet (mil gals)	Specific Conductance (µS/cm)	TDS (mg/L)	Volume Available (mil gals)	Fish Confirmed (codes below)
CD-7 Area (Cont'd)								
M0024	141.1	8.2	236.9	--	112	70		NSSB
M9903	70.2	22.1	168.5	8.1	87	126	168	No
M9904	25.2	9.3	25.5	0.1	210	61	25	No
M9905	24.6	11.3	30.2	0.2	85	112	30	No
M9910	146.5	9.0	306.4	2.5	127	84	2	GRAY
M9914	151.1	7.8	205.1	--	90	61		BKFH, GRAY, NSSB
M9915	30.6	7.1	33.7	0.01	89	120	34	No
M9922	195.9	6.1	246.9	--	159	140		NSSB
M9923	255.0	6.7	289.6	--	265	136		NSSB
R0070	114.1	3.6	44.6	--	266	--		ns
R0071	90.3	2.7	26.5	--	124	--		ns

Sources: Moulton 1996a, 1996b, 1999a, 2000, 2001, 2002; CPAI 2002; Moulton 2002; CPAI 2002; L.L. Moulton unpublished.
Notes:
Lake volumes for L9210 and M9313 updated with 2000 depth data.
Lake volumes for L9323 and L9324 updated based on contour mapping with 2001 data.
Water chemistry: some lakes have multiple years of measurements; most recent year is included.
-- = not calculated or no measurement taken
ns = not sampled
Fish Species Codes
ARCS = Arctic Cisco
BDWF = Broad Whitefish
BKFH = Alaska Blackfish
CHUM = Chum Salmon
DCHAR = Dolly Varden
FHSC = Fourhorn Sculpin
GRAY = Grayling
HBWF = Humpback Whitefish
LAMP = Arctic lamprey
LNSK = Longnose Sucker
LSCS = Least Cisco
NSSB = Ninespine Stickleback
RDWF = Round Whitefish
SLSC = Slimy Sculpin

The amount of lake water withdrawn for exploration, ice roads, and pads is typically well below the permitted volume (Bill Morris 2004, pers. comm.). Most research has clearly shown that typical withdrawal volumes (less than 5 % of the water below 7 feet of ice, with few exceptions) do not significantly impact the lake (Michael Baker Jr., Inc. 2002e, 2002h). Cases in which more substantial volumes of water have been withdrawn from lakes, rigorous water quality data are not available for comparisons or analyses. CPAI will monitor each water withdrawal to ensure winter water use does not exceed permit limits. Depending on the proposed level of use (e.g., the same lake used year-round, year after year), water quality monitoring (e.g., temperature, dissolved oxygen, specific conductivity, and pH profiles) and lake recharge monitoring could be required by the permit(s). Annual fish monitoring may be required for heavily used lakes. Monitoring for these and potentially other parameters could be prescribed at individual water bodies on a site-specific basis (Bill Morris 2004, pers. comm.). Data from such monitoring and other future studies would be integrated with assessments of impacts to lake habitat to determine if modifications of permit stipulations are necessary (e.g., changes in water withdrawal limitations, additional water quality monitoring, or changes to existing lake observation programs, etc.).

In addition, to minimize impacts on fish, large and deep lakes would be targeted as water sources to allow a margin of safety for maintaining sufficient water volumes. Shallow lakes that do not contain fish also will be used as water sources before they freeze. No impacts to fish are expected if CPAI adheres to the water withdrawal permit conditions. Additionally, screened intake structures specially designed to eliminate the potential for fish being impinged, entrained, or entrapped by water pumps will be used at all fish-bearing water sources. Pursuant to State of Alaska standards, (1) screens must have appropriately sized mesh to ensure that all life stages of fish likely present during pumping cannot swim through the screen and (2) the velocity at any given point along the outer screen must be below the velocity of the weakest fish species and life stage burst swimming speed. Industry requires that each contractor use screened intakes certified by the ADNR (Bill Morris 2004, pers. comm.).

GRAVEL MINING

To provide road and pad material, gravel will be mined at locations to be determined. Mining related activities include gravel mine pits, blasting of frozen gravel (to allow loading and transportation), and gravel stockpiling. Such activities in or near overwintering and spawning habitat are likely to adversely affect fish by reducing the amount and quality of available habitat. Direct and indirect impacts to fish from gravel extraction are most likely to occur within the floodplains of rivers. Detrimental effects could include loss of spawning and overwintering habitat (if not identified before extraction); blocking and rerouting of stream channels; high silt concentrations resulting in reduced primary production, loss of invertebrate prey species; mortality of fish eggs and larvae; and disruption of feeding patterns for sight-dependent feeders (BLM 1989). If the aforementioned activities occur outside overwintering or spawning areas, little or no adverse effects on fish would be expected.

One of the potential beneficial aspects of mining in or near riverbeds and floodplains is that it creates deep-water pools. Extensive studies by the ADF&G have shown that these pools may subsequently be used by fish to overwinter and spawn once the active site is abandoned (Hemming 1988, 1990, 1991, 1993, 1994, 1995; Hemming et al. 1989). Site reclamation may include constructing or enhancing access channels from surrounding streams and rivers, subject to the approval of ADNR fisheries biologists. Such excavation would affect terrestrial biota. To be a viable candidate for fish habitat creation, these and any gravel mine sites that may be used for the project must be sufficiently near a fish-bearing body of water so that digging a connection between the gravel pit and the water body is not prohibitive.

The existing ASRC Mine Site and Clover are sites being considered as gravel sources. There is no evidence to suggest that noise and vibrations from activities at the existing ASRC Mine Site (Figure 4A.3.2-1) affect fish as it is not located close to fish bearing waters. It is also unlikely that the ASRC Mine Site will eventually yield additional fish habitat subject to reclamation. The existing ASRC Mine Site was not designed with post-operational fish habitat creation in mind. Converting the pits into fish habitat was deemed not feasible during the original permitting of the mine site in 1998 (Louise Smith 2003, pers. comm.). There already is an multi-agency/industry-approved rehabilitation plan for the ASRC Mine Site. Should a connection be made to the Colville River, approximately 0.15 mile away, the site would probably become saline at depth (Bill Morris 2003, pers. comm.) because the bottoms of the pits are higher than the mean water level of the Colville. Connecting the pits to the river would create a deep crater that would flood during break-up and end up trapping fish once surrounding water levels subsided (Louise Smith 2003, pers. comm.). Furthermore, a channel cut to the mine site may exacerbate the thermokarsting and erosion that is presently occurring along the east bank of the river (Louise Smith 2003, pers. comm.).

Clover (Figure 4A.3.2-1) would also be located outside overwintering and spawning areas and is not likely to be a threat to fish stocks. The proposed boundary of Clover is too far from both the Ublutuoch River and the small tributary that is heavily used by fish (Bill Morris 2003, pers. comm.) south of Clover to create potential fish habitat. The current rehabilitation plan for Clover (Appendix O) includs an inflow/outflow in the southwest corner of the pit, the area closest to the nearby tributary. The focus of restoration is the creation of waterbird resting, feeding, and nesting habitats (Appendix O).

PIPELINES

The pipeline crossing the Nigliq Channel and the Ublutuouch River will be on the road bridge, and bridges will carry the pipeline across three channels between CD-1 and CD-3; the potential impacts of bridges are discussed below. Other water crossings along the proposed pipeline alignment are not wide enough to require pipeline bridges. Pipelines will span the crossings on VSMs. The construction of pipelines on VSMs at waters supporting fish may displace small numbers of fish short distances as a result of temporary disturbance from equipment working on the ice. However, those fish affected could soon reoccupy that habitat upon completion of the activities and would be otherwise unaffected. Given that construction activities are in the winter and overwintering habitats would be largely avoided, it is expected that pipeline construction under Alternative A would have no measurable effect on arctic fish populations in the Plan Area.

PADS, ROADS, AND AIRSTRIPS

Gravel placed for production pads, roads, and airstrips has the potential to eliminate some fish habitat. Generally, proposed pads and gravel roads have been situated to avoid lakes and drainages in the Plan Area.

Near CD-3, the primary fish habitats that are likely to be affected include a small pond and wetland that would be crossed by the airstrip and potentially Lake M9313, which is immediately north of the pad and airstrip facilities (Figure 4A.3.2-1). The pond and wetland areas are too shallow to be used year-round, but ninespine stickleback may use the area during summer. The area covered by gravel fill would be lost as stickleback habitat.

Construction of an ice road or an airstrip on fish overwintering areas may cause water to freeze to the bottom and form a barrier to water circulation that in turn may reduce dissolved oxygen levels, even if water were not withdrawn. This could have lethal effects on overwintering fish affected by the barrier. To guard against this possibility, regulations require that ice road water crossings be sited where the ice in the watercourse naturally becomes bottom fast (grounded) each winter (i.e., where the flow would naturally be blocked even if the ice bridges were not present). Alternatively, if the crossing were to occur where ice does not ground naturally, the crossing would be permitted only if it would not thicken the ice to the point that it does become bottom fast (Bill Morris 2004, pers. comm.). AS41.14.840 requires fish passage be maintained. General Conditions 5 and 34 outline some of the specific requirements that must be met. Therefore, to mitigate impacts, ice roads and airstrips should avoid known fish overwintering areas if these requirements cannot be met.

Fish movement is minimal in most of the Plan Area during winter because most of the access channels between deep water bodies are frozen to the bottom. Watercourses that may support overwintering fish (such as the Nigliq Channel and Ublutuoch River) will be spanned by bridges. Therefore, winter construction of production pads, roads, and pipelines is not expected to result in any obstructions to fish passage. The Nigliq bridge would, however, have multiple large piles and ice-breaking piers installed in the channel during winter (see further discussion below under "Bridges").

Another impact related to production pads, roads, and airstrip construction is erosion and subsequent in-stream sedimentation. This is addressed in detail in the Pads, Roads, and Airstrips subsection under Operation Period below.

BRIDGES

Shallow lakes and connecting small waterways are used by fish in summer as migration corridors and feeding habitat. Because of this, a combination of culverts and bridges has been incorporated in the road design of this alternative to ensure free passage of fish within area waterways and habitats. These water crossings are integral features to road development. Culverts are addressed in the following subsection. CPAI has proposed to install bridges at seven sites where roads would cross water bodies (Figure 2.4.1.1-1):

- A 1,200-foot bridge across the Nigliq Channel between CD-2 and CD-5;
- An 80-foot bridge across Lake 9305, between CD-2 and CD-5;
- A 40-foot bridge approximately 1.3 miles south of CD-5, between CD-5 and CD-6, across a channel extending north from Oil Lake (N77097, Figure 4A.3.2-1);
- A 120-foot bridge across the Ublutuoch River, between CD-5 and CD-6;
- A 40-foot bridge approximately 0.8 mile west of the Ublutuoch River, between CD-5 and CD-6, across an unnamed beaded stream that flows into Lake L9824 (Figure 4A.3.2-1) and connects to the Ublutuoch River;

- A 40-foot bridge approximately 1.1 miles east of CD-6, between CD-5 and CD-6, across an unnamed beaded stream that flows into Lake MC7917 (Figure 4A.3.2-1) and connects to Fish Creek;
- A 40-foot bridge approximately 1.4 miles east of CD-7, between CD-6 and CD-7, unnamed beaded stream and small pond that flows from a small unsampled lake to Lake M0024 (Figure 4A.3.2-1) .

These bridges would be constructed in winter when most of the water bodies that would be crossed are frozen, and fish would therefore not be present when construction occurs. Furthermore, for all road bridges except the Nigliq Channel and Ublutuoch River crossings, in-channel piers are not required. Because of this, at those locations, no fish habitat losses or alterations are expected from bridge construction at these sites.

The Nigliq Channel and the Ublutuoch River do not completely freeze. Fish winter both upstream and downstream from both bridge crossing sites, and the locations are likely spawning sites for multiple species (Bill Morris 2003, pers.comm.). If impacts were to occur due to winter construction, they could be substantial. However, at the Nigliq Channel and Ublutuoch River, the bridges span only the main channel and the gravel approaches are in the floodplain terrace(s), Fish habitat would be altered and fish movements could be disrupted during flood events when the river rises above the level of the main channel and flows on the floodplain.

Figures 2.3.9.1-8 and 2.4.1.1-14 show that the preliminary design of the Nigliq Channel Bridge would have two instream piers, with icebreaking structures. Borings required for pier installation would be required and would produce cuttings consisting of all soil materials encountered during drilling. The cuttings would be hauled by truck back to the location of gravel sources used for gravel road construction and placed in the waste-material area of the pit. Whereas most of the cuttings from the pier borings would be collected and hauled away by truck, it is likely that some fraction would escape and produce temporary turbidity plumes in at least the bottom to mid-depth water layers. Review of salinity data presented in Moulton (2001) shows a pronounced density gradient separating lighter water above from denser water below. This density gradient can be present in this region of the channel at about the 0.5- to 1-meter water depth from the overlying ice, and it can be strong enough to prevent mixing of dissolved oxygen levels throughout the water column. Turbidity plumes from the drilling of the support piers could suspend oxygen-demanding materials in the bottom and mid-depth water layers, potentially decreasing dissolved oxygen to levels stressful or lethal to fish. These materials would not be swept away because there is expected to be no or only minimal flow in the Nigliq Channel in winter. At the Kuparuk River east bridge during April 2001, suspended solids were still present in the water column from construction in late October 2000 (Bill Morris 2003 pers. comm.). Thus, increased sediment loads will likely remain elevated in the Nigliq Channel throughout the winter until flows return in spring.

Because the Nigliq Channel bridge spans the main channel but not the floodplain; a substantial portion of the floodplain terrace to the west of the channel would be bisected by gravel fill. Because construction will be in winter, the floodplain will be under neither water nor ice, and thus no impacts of gravel placement are expected.

At the Nigliq Channel Bridge, if a region of low dissolved oxygen were to develop at the bottom and mid-water depths due to construction (from drilling of pilings and suspension of sediments), this anomaly could create a physiological barrier and temporarily obstruct winter fish movement through the area. Fish from downstream areas might not be able to move upstream and vice versa; this may result in overcrowding, with potential adverse effects over time as fish use up dissolved oxygen (since water is not flowing). Construction noise may also pose a barrier to fish movement during the winter of construction.

This area of the Nigliq Channel has emerged as a highly important fishing area. Effort has gradually shifted downstream in the Nigliq Channel during 15 years of monitoring (Moulton 2001). In 1993, fishing effort in the middle part of the Nigliq Channel exceeded that in the upper Nigliq area for the first time, and in 2000 about 37 % of the total Nigliq Channel fishing effort was in the middle Nigliq Channel near the proposed bridge site. If dissolved oxygen levels were depleted in this region, a substantial amount of the available winter habitat may be rendered unusable and result in a temporary displacement of the fishery and/or temporary loss of important subsistence fishery resources. Impacts of winter bridge construction would not affect the end of the fall under-ice fishery that runs from late September through late November. One of the fishing hot spots is in the Nanuk area of the Nigliq Channel close to the proposed bridge location. This is the major fishery of the year and targets Arctic cisco, least cisco, humpback whitefish, broad whitefish; species taken incidentally include Bering cisco, Arctic grayling, rainbow smelt, round whitefish, Dolly Varden, burbot, Arctic flounder, and fourhorn sculpin.

CULVERTS

Culvert Batteries

CPAI has proposed to install culvert batteries instead of bridges at five sites where roads would cross water bodies (Figure 2.4.1.1-1):

- Across the narrow portion of Lake 9323 (Figure 4A.3.2-1) just north of CD-4;
- Across a wet sedge meadow adjacent to Oil Lake (N77097 in Figure 4A.3.2-1) and an old basin wetland complex, approximately 1 mile south of CD-5;
- Across an unnamed beaded stream that flows into the Ublutuoch River approximately 1.8 miles west of the Ublutuoch River, between CD-5 and CD-6;
- Across a small tundra drainage area that flows north approximately 3 miles west of the Ublutuoch River, between CD-5 and CD-6;
- Across a small tundra drainage area that flows into Lake M0254 approximately 2 miles southwest of CD-6.

Culvert designs (See Section 2.3.9 and Figures 2.3.9.1-9 through 2.3.9.1-11) and locations will meet the objectives of maintaining water flow/connectivity and ensuring freedom of fish movement. CPAI intends to incorporate into its culvert designs the Culvert Installation Standards in the Alaska Administrative Code (5 AAC 94.260). Proper design would require knowledge of fish species present and the water velocities at flood stage of each watercourse.

The gravel bed supporting the 32-foot-wide road would place fill in the waterbody at each culvert battery crossing (Figure 2.4.1.1-1). At Lake 9323 (Figure 4A.3.2-1) near CD-4, this corridor would be approximately 90 feet wide (the width of the base of the road bed). This filled area constitutes a negligible portion of the total fish habitat available in this lake.

Bottom disturbance during culvert installation, plus sediments associated with the gravel, would increase suspended sediments (see above for discussion of sedimentation impacts) and possibly decrease dissolved oxygen levels. Reduced dissolved oxygen from the combination of water withdrawal and culvert installation could potentially eliminate the fish residing in water bodies during the two winters of construction if they cannot avoid the sediments. Visual interference is not expected to be significant, as these fish are not feeding during winter. Lake 9323 (Figure 4A.3.2-1), which contains fish, would be impacted during two winters by construction of the proposed road to CD-4. These temporary disturbances would be localized and have no measurable effect on fish populations in general within the Planning Area.

Cross-drainage Culverts

CPAI will install cross-drainage culverts (Section 2.3.9) in road beds to maintain natural surface drainage patterns.

OPERATION PERIOD

PIPELINES

The normal operation of the pipelines should have only negligible effects on fish habitat or fish movement corridors. Fish habitat would not be lost or altered by the presence of VSM-mounted pipes. Because most planned maintenance and repair activities would occur in the frozen season to allow ground access to pipelines even where there are no adjacent roads, little impact would be expected. Should urgent repairs be needed when the ground is not frozen, impacts should be negligible where the pipeline is adjacent to the road (that is, to CD-4, CD-5, CD-6, and CD-7). Along the pipeline to CD-3, which would not be adjacent to a road, vehicular access for emergency maintenance would necessitate traveling over unfrozen tundra and three river channels; however, effects on fish would still be expected to be minimal and short term (e.g., minor sedimentation as low-ground-pressure vehicles passed through drainages)

PADS, ROADS, AND AIRSTRIPS

During periods of high water, fish may use low-lying areas that are covered with water. Therefore, even at locations remote from defined watercourses, gravel production pads, roads, and airstrips potentially may alter water flow patterns on a landscape scale and thus impede fish passage to and within water bodies. They can also interfere with migrations to spawning, feeding, and overwintering sites if improperly designed. Waters flowing out into the floodplain could pond against the solid-fill roadways. Excessive ponding might lead fish to move into and area and be stranded once water levels subside. Installation of bridges or culverts in roadbeds in low-lying areas to ensure fish passage during high water conditions could mitigate this concern.

Least cisco have been documented to use Lake M9313 (Figure 4A.3.2-1) near CD-3, and ninespine stickleback likely use the pond and wetland area crossed by the airstrip. The main route of fish migration into and out of Lake M9313 is thought to be through a small channel on the northeast side of the lake. A connection between the lake and the West Ulamnigiaq Channel in this area is established when the river channel complex in this region is over-topped during high water. Because this area is remote from the proposed production pad and road, it is not likely that there would be any impacts on fish movements into or out of the lake and wetland area. Access to the wetland area in question is likely from the north through the same wetland complex connecting Lake M9313 to the river channel.

The proposed road and production pad in the CD-4 area could alter some flow entering or leaving three nearby perched lakes—M9524, L9323, and L9324 (Figure 4A.3.2-1)—and thus affect movements of fish including broad whitefish and least cisco. Thus, any changes in flow patterns that disrupt migration routes, particularly during break-up, could reduce or increase the number of broad whitefish and least cisco entering or leaving the lakes for the duration of the project. Therefore, to prevent impacts to overwintering fish, ice roads and airstrips should be constructed to avoid known overwintering areas.

Additional threats to fish and fish habitat associated with gravel-base structures are erosion and subsequent in-stream sedimentation. Destructive effects from erosion and subsequent instream sedimentation may occur when silt/clay-laden water flows out of roads, pads, and airstrips made out of poor quality (e.g., high clay content) gravel. Maintenance of road surfaces at or near lake crossings could increase the amount of suspended sediments in the lakes, resulting in degradation of water quality and fish habitat. Failure of any portion of a road within a lake and subsequent repairs also would be expected to degrade water quality and fish habitat within the lake. Heavy sediment loads could silt out spawning areas and smother eggs, or interfere with respiration of newly emergent fry (Cairns 1968 cited in DenBeste and McCart 1984a). Heavy sedimentation could also affect invertebrate communities that serve as food sources for fish, and interfere with visual feeding in fishes. Sublethal impacts to fish from sedimentation are a further concern in streams. Effects such as avoidance, reduced feeding (e.g., from visual interference), gill damage (Lake and Hinch 1999), and lessened tolerance to disease can combine to reduce fitness and survival. Habitat fouling would be especially detrimental if it occurred in a critical habitat segment of a river.

Determining if the sediment loads attributable to pad and roadway erosion are sufficient enough to adversely affect invertebrate and fish communities is problematic. DenBeste and McCart (1984a, 1984b) found that the excessive introduction of sediments from pipeline related activities in Atigun Pass did not appear to have any detrimental effect on Atigun River benthic invertebrate communities or local fish communities. With the exception of a seasonal shift in the density in the stonefly *Podmosta*, the invertebrate benthic communities in the North Fork Chandler River were unaffected by heavy sediment loads associated with pipeline activities (DenBeste and McCart 1984a, 1984b). In fact, Chironomid larvae, which are the dominant food item for fish in the North Fork Chandler River, were actually more abundant in turbid waters than correspondingly clear tributaries. Given that high sediment loads characterize many North Slope rivers and streams during breakup and flooding, it is likely that fish and benthic invertebrate communities inhabiting them are somewhat adapted to regular exposure to heavy sedimentation. CPAI would remove snow from the road surface to minimize runoff, road erosion, and tundra silting during the spring melt. It also is important that gravel with low silt and water content be used; roads, pads, and airstrips made of gravel with high silt and water content may simply spread laterally onto the tundra as the water thaws in spring (e.g., the Meltwater road and pad). Silt fencing is not a practical mitigation solution for several reasons: it would block passage of waterfowl, and in particular the young and the flightless would become extremely vulnerable to predators (e.g., foxes); anchoring the bottom of silt curtains to ensure effective sediment filtration and allow them to stand up to wind and water forces would most certainly kill the tundra where they were anchored; and silt curtains at bridges and other drainage crossings in all likelihood would wash out during the flood events or be torn up by bears, foxes, and high winds and ultimately become a litter problem (Steve Schmitz 2004, pers. comm.).

BRIDGES

If bridges do not span the Nigliq Channel and Ublutuoch River floodplains, but rather include in their design gravel bridge approaches across the floodplain terraces, the normal flood-stage hydrology of the two watercourses would be altered.

At the Nigliq Channel, hydrologic constraints have been considered for constructing the floodplain segment of the road (on the west side of the channel). The road has been designed to accommodate a 200-year return flood event, plus 1 foot of freeboard. Other hydrologic factors that are being considered in bridge design include scour protection, ice jams, and storm surges. The considerations should prevent bridge or road failure. However, if the bridge or road in this area did fail, the primary impacts would be related to oil spills. Potential impacts from spills are addressed in Section 4.3. Also, debris resulting from a bridge failure potentially could be an additional flow disruption and could obstruct fish movements in the main channel.

Extending the road's bridge approaches across the floodplain terrace on the west side of the Nigliq Channel would constrict the channel, which would result in increased flows and likely scouring of the bottom during flood events. This could severely alter floodplain vegetation. Scouring might actually have beneficial effects by increasing overwintering habitat locally. This has occurred at spur dikes constructed along the upper reaches of the Sagavanirktok River (Martin et al. 1993).

The constriction of the channel may also increase the likelihood of ice jams, followed by flooding, then by pulse floods down the channel when the ice jams break up. These events would adversely alter fish habitat in the vicinity of the bridge. If ice jams occur, fish could be dispersed over the floodplain as water levels rose and then be stranded when the ice jam broke up. Substantial numbers of fish could be affected because the Nigliq Channel is a major overwintering site.

Features such as bridge piers often attract and hold fish. However, the instream piers at the Nigliq Channel bridge would alter water flow resulting in bottom scour at and around the bridge. If scour is significant enough you could see some concentrations of saltier water within the scour hole and possibly some effects to the upstream migration of the saltwater front. This could alter the arctic cisco distribution in the channel during the early winter fishery that occurs below the ice. Furthermore, the persistence and extent of saltwater intrusion could change during the summer months when freshwater fish are harvested from the channel. There is potential to decrease the freshwater habitat by allowing more saline water intrusion, which would result if the stream-bed were lowered. (Saltwater intrusions in coastal rivers tend to move upstream to where the riverbed becomes higher than sea level.) Freshwater fish would be displaced to other habitats within the river if this were to occur. If enough material is scoured from the bridge location and deposited downstream (thus raising the bed of the river below the bridge) alterations to upstream movement of saline water and fish could occur. This is a common occurrence at undersized crossing structures. During some flow conditions, some rivers lose surface water flow as water flows below the material deposited downstream from scour. The proposed bridge design makes it likely that flow restriction and potentially some of the above-described impacts will occur during some floods. Modifying the Nigliq bridge design to be least restrictive to flow during high water events would result in little expected impact (Bill Morris 2004, pers. comm.).

Impacts to the floodplain at the Ublutuoch River crossing, where there are terraces on either side of the main channel would be similar to those at the Nigliq Channel bridge. Building the Nigliq Channel and Ublutuoch

River bridges so that they span the floodplain terrace(s) in addition to the main channel would mitigate these impacts. If flow alterations at bridges were to cause significant erosion, the resulting sedimentation may affect fish passage; also, salinity regimes at the Nigliq Channel may be altered, as described above. Bridges appear to produce far less bank and stream erosion than do culverts; and when bridges are sufficiently large, bank erosion should be very minimal (Bill Morris 2004, pers. comm.). See the following subsection (Culverts) for additional discussion on effects of sedimentation. Disruptions at the Nigliq Channel during the summer would affect the broad whitefish fishery, which operates in various sections of the Nigliq Channel (other species taken incidentally during summer are Dolly Varden, humpback whitefish, pink salmon, and chum salmon). Summer impacts also could affect the fall fishery, as described above in the Construction subsection.

Should bridge approaches wash out, effects of sedimentation would be similar to those described above for pads, roads, and airstrips.

CULVERTS

Current concerns related to pad and road placement include diverting or eliminating flow from small tributaries that connect lakes or that connect lakes and rivers. Potential loss of migratory capacity could stress or kill fish if the fish were unable to migrate to food-rich habitat in the summer, reach spawning areas, or move into overwintering habitat. Proper placement of culverts is critical in minimizing impacts to fish.

CPAI will design the culverts proposed for this project to maintain adequate water flow and fish passage. Obstructions to fish movement are most common when culverts or low water crossings are not properly sized to allow for the passage of fish during critical migration periods (Elliott 1982). Culverts also should be designed to avoid clogging which would cause impounding upstream of the structure. In addition, culverts on the North Slope have frequently caused downstream channel morphology changes. This has the potential to eliminate considerable habitat downstream of the culverts.

Given the 30-year history of culvert construction on the North Slope, design features should adequately address the above concerns. However, long-term problems will likely arise at culvert crossings of the relatively deep (very low width/depth ratio), highly sinuous, slightly entrenched streams typical of the National Petroleum Reserve-Alaska and the North Slope in general. The high discharges of many of these streams are too great for culverts to accommodate, given the fill required for culvert pipes at many of the streams in the National Petroleum Reserve-Alaska (Bill Morris 2004, pers. comm.). This only will be a fish issue if culverts are used in streams with significant fish use. The ADNR permitting process will work to avoid this.

Should culverts fail to be properly maintained or meet their intended goals, access by fish to critical summer rearing grounds could be restricted or lost. If culverts were to cause significant erosion, fish passage may be compromised. Increased sedimentation would likely impact the Ublutuoch River more than any of other streams or rivers crossed by the proposed facilities and roads in Alternative A. The river below and around the Ublutuoch crossing is deep and slow moving, and it has a gravel substrate. Increased sedimentation from erosion of the bed and banks could cover the gravel substrate to some extent, thereby reducing the productivity of the river to rearing fish and reduce the amount of gravel available for spawning. It is likely that deposited material would be persistent on the streambed (Bill Morris 2004, pers. comm.).

HUMAN ACCESS

The project could create a limited number of new jobs, which may attract new residents from Barrow or other North Slope villages to reside permanently in Nuiqsut and use local fishery resources. The expected small magnitude of the potential increase in subsistence users that would be attributable to the development makes it unlikely that there would be adverse effects on the subsistence fishery. Furthermore, the project would not increase fishing competition between residents and local non-residents because CPAI has agreed to apply a no-fishing/hunting policy to non-resident workers.

Construction of roads during winter could encourage local fisherman to fish the Ublutuoch River fish overwintering area as well as Fish and Judy creeks. This could result in a more than negligible increase of fishing pressure on overwintering fishes.

Theoretically, the new roads (gravel and ice) could provide easier access from the Colville River Delta to the area of new development. However, there is no road access from Nuiqsut to the new roads. There is potential for increased access to the lower Ublutuoch River during winter when fish are concentrated in the lower river for wintering and spawning (Morris 2003, pers. comm.). However, the no-fishing or hunting policy for non-resident workers would prevent others from using fish resources along or near the new roads. Therefore, we do not expect that the new roads would result in increased human access and harvest of fish. Conversely, because local subsistence users tend to avoid areas near industrial activity, there may be some decreased use of some traditionally used areas because of the proximity to oilfield facilities. Even should local residents take advantage of the new roads, the extent to which subsistence harvests and thus pressures on certain species, especially whitefish in the subsistence fishery may increase is uncertain. Fishing effort and yield can fluctuate in conjunction with natural perturbations in the abundance of target species. For example, the size of the Arctic cisco population that overwinters in the Colville Delta may vary drastically over the course of several years based solely on meteorological conditions that occurred 5 to 7 years earlier. Strong stocks and good yields may prompt fisherman to expend more fishing effort, whereas weak stocks and low yields may discourage fishing. As with many fisheries, assessing the effect of varying fishing pressure and exploitation rates that are exerted on the resources is less a matter of prediction than it is a matter of constant monitoring. Fisheries within the Plan Area would be no different. Presumably, the Colville River Delta fisheries are presently managed on a sustained yield principal. The BLM manages subsistence, commercial, and sports fish harvests on BLM lands, the State manages commercial and sports fisheries on state lands, and the USFWS manages subsistence fisheries. Continued monitoring should provide the mechanisms for preventing overfishing regardless of cause.

ABANDONMENT AND REHABILITATION

Water withdrawal and removal of bridges, culverts, and bridge approaches could have impacts on fish similar to those described for construction activities. Additional fish habitat may be created by allowing gravel pits to be colonized by fish from nearby streams or if they are within the floodplain of nearby streams.

4A.3.2.2 Alternative A – Full-Field Development Scenario Impacts on Fish

Types of impacts of future development in the Plan Area generally will be similar to those described above for the five-pad CPAI proposal (Section 4A.3.2.1). However, development on the scale postulated will, depending on precise siting, destroy or alter fish habitat substantially more than CPAI’s proposed plan. Overwintering, rearing, migration, and spawning habitats would be affected.

The road and pipeline network could subtly alter flows of waterways on a landscape scale that could lead to unexpected shifts in drainage and loss of fish resources. Impacts to fish passage would be minimized by installation of culverts or bridges as determined during future permitting efforts. However, culvert failure (Section 4A.3.2) could cause widespread habitat alteration and obstruction of fish movement.

The extent of road development under this scenario, including a possible road to or near Nuiqsut, suggests that there would be increased potential for human access to fish resources throughout the Plan Area, thus creating greater pressure on fish populations. Conversely, some traditional users of the area may choose other locations to avoid industrial activity altogether.

State-of-the-science construction and operation approaches would be used to minimize impacts, and human access to resources could be controlled as described in Section 4A.3.2. Withdrawal of fresh water necessary to support this scale of infrastructure development, plus well drilling, should not affect fish if withdrawals are done in compliance with permit restrictions. The effects of this FFD scenario are expected to be similar to effects from similar current developments.

The following subsections summarize concerns specific to facility groups.

COLVILLE RIVER DELTA FACILITY GROUP

In the Colville River Delta, seven new production pads are hypothesized. Of particular note are production pads HP-12 and HP-14, on the eastern side of the outer Delta, which are in the vicinity of the commercial (Helmericks) fishery as well as subsistence fisheries. Spills, addressed in Section 4.3, would be a major concern of these two hypothetical facilities.

No roads are hypothesized in this part of the Plan Area. Pipelines would be constructed over several major watercourses including the Elaktoveach Channel, Kupigruak Channel, Tamayayak Channel, and the main stem of the Colville River. Instream construction activities at these water bodies would have the potential to cause impacts as described in Section 4A.3.2.

FISH-JUDY CREEKS FACILITY GROUP

Eleven new pads plus one new processing facility in the Fish Creek watershed (including Judy Creek and the Ublutuoch River) are hypothesized.

Several facilities would be situated in sensitive areas designated by the BLM and the MMS (1998a): hypothetical production pads HP-4, HP-16, HP-17 and processing facility HPF-1 in the Fish and Judy creeks drainages and HP-11 near the Colville River. Fish habitats in these drainages are important for spawning, migration, rearing, and overwintering for anadromous and resident species. This may affect subsistence fishing, because local subsistence users do not like to fish near development, especially industrial development. Thus, they do not want oil company structures near where they fish.

The road network of this hypothetical development is extensive. If roads are not routed along high ground to the extent possible, relatively large areas of fish habitat may be affected during road construction. The roads from CD-7 to HP-18 and from CD-6 to HP-15 are perpendicular to the primary drainage flow and thus may function as dams on a landscape scale, disrupting natural hydrology and obstructing fish movement over a wide area. Bridges or culverts installed in low-lying areas might mitigate this effect.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Four new pads and one new processing facility in the Kalikpik-Kogru rivers drainages are hypothesized.

As with the Fish-Judy Creeks Facility Group, the road network of this hypothetical development is extensive. Therefore, relatively large areas of fish habitat could be affected during road construction if roads are not routed along high ground to the extent possible. The road from HP-18 to HPF-2 is perpendicular to the primary drainage flow and thus may function as a dam on a landscape scale, disrupting natural hydrology and obstructing fish movement over a wide area. Bridges or culverts installed in low-lying areas might mitigate this effect.

4A.3.2.3 Alternative A – Summary of Impacts (CPAI and FFD) on Fish

Within the Plan Area, the primary impacts of concern are those that affect winter habitat, as well as those affecting feeding and spawning areas and access to these areas. Water withdrawal for winter construction could create overcrowding and reduce the available pool of dissolved oxygen in a water body, possibly resulting in fish mortality. Permit limits on amounts of water withdrawn are set to avoid such impacts.

Gravel mining could have adverse effects on fish if located within the floodplains of rivers near natural overwintering and spawning areas. Proper siting to avoid these habitats could easily minimize this problem. Sedimentation from erosion could affect fish and other aquatic organisms by interfering with respiration and vision or by smothering benthic habitat (Cairns 1968 cited in DenBeste and McCart 1984a). These impacts would tend to be localized downstream of the site. Again, proper siting away from major river channels would further localize adverse effects to fish. In general, limited mining would not have a measurable affect on fish population within the Planning Area. Mining in main migratory channels should be avoided. There also is potential for future gravel mines within floodplains to result in new deep lakes that provide valuable fish habitat, however implementation of such a strategy may be problematic.

As designed, the bridge approaches at the Nigliq Channel, other major Colville River channels, and the Ublutuoch River extend into the floodplain terrace(s), and thus would alter river flow during flood stages. Funneling would occur but only in years of unusually high flooding. In such cases, increased flow rates could affect fish movement. The effect on fish movements and migrations would be temporary and intermittent and not likely to have a long-term impact. Scouring caused by flow effects around bridge piers may cause sedimentation and alteration of salinity regimes, in turn displacing fish to other habitats. Low dissolved oxygen may also result from suspension of oxygen-demanding materials during construction of the Nigliq Channel bridge.

If culverts (proposed in five locations; see Figure 2.4.1.1-1) are improperly sized, water may be impounded during periods of high flow upstream of the passage thereby increasing flow velocity within and downstream of the structure. Fish migrations could be affected. Improperly engineered culverts can also impair fish movement during periods of low water flow (Elliott 1982). Culverts should therefore be designed and constructed to be large enough to avoid the restriction of fish passage or adversely affect natural stream flow. Stream morphology changes may occur downstream of culverts as a result of altered flow.

The long network of roads may result in alteration of regional surface hydrology, including interruption of fish movements. Construction of ice roads or airstrips on fish overwintering areas may cause freezing to the bottom and block fish movement if state requirements to maintain fish passage are not met. The new road system–both ice roads in the winter and gravel roads in the summer–may facilitate increased human access to fishing areas, potentially increasing subsistence fishing pressures.

Release of contaminants over the project duration and the impacts of oil spills are important concerns to fish resources; these issues are addressed in Section 4.3.

The potential impacts described above, should they occur, are likely to be localized and temporary and thus would have negligible effects on fish populations within and adjacent to the Plan Area. Given the total amount of construction proposed, the collective effects of development and production will have some effect on fish and fish habitats in the region. Whether those effects are measurable and distinguishable from naturally occurring population perturbations is unknown. Minor shifts in habitat or population integrity, especially if they are of a temporary nature, could reasonably be absorbed by the ecosystem. Furthermore, careful planning, appropriate engineering specification and design, and rigorous safety measures should minimize impacts and ensure the reproductive sustainability of stocks overall. Localized impacts could pose a more serious threat to localized (e.g., within a single drainage) stocks if they were to occur in or near prime spawning, nursery, or overwintering sites. For example, large number of broad whitefish winter in the lower Ublutuoch River, upstream and downstream from the proposed bridge; substantial impacts to that area during winter could cause a loss of the majority of Fish Creek drainage broad whitefish, as many of the spawners and most age classes would be represented at the same place and the same time (Bill Morris, pers. comm.). Continued monitoring of fisheries resources is vital to the long-term stability of the region. Monitoring and mitigation plans should be finalized and ready to address any signs that development may be having a truly detrimental effect on local fish populations.

ESSENTIAL FISH HABITAT

The primary EFH concerns in Alternative A include potential effects on salmon associated with water withdrawal, alteration of flow patterns (e.g., by bridge approaches in floodplains), release of contaminants, project-induced erosion, and oil spills. The only fresh water bodies identified as EFH (chum and pink salmon only) within the Plan Area are Judy Creek, Fish Creek, the Ublutuoch River, and the Colville River. Estuarine and marine waters bordering the Plan Area are EFH for all five species of salmon.

Potential impacts of oil spills are addressed in Section 4.3. Effects of water withdrawal have been mitigated by restricting the withdrawals to permitted levels established to afford protection to resident fish. Further, monitoring of these withdrawals is planned to ensure that permitted levels are not exceeded.

Bridges would be used at the major stream and lake crossings as described in Section 2.3.9, and culverts would be installed in other areas.

Assuming that culverts are properly designed and sized, these actions should ensure accessibility among area habitats. While contaminants likely would be released in conjunction with normal operations, a strong commitment to spill and emissions control and rigorous spill response protocols should prevent EFH water bodies from being adversely affected. Salmon would not be expected to be present in the Nigliq Channel in winter; therefore, construction of the Nigliq Channel bridge would not be expected to affect EFH. Winter construction of the bridge across the Ublutuoch River could impact chum or pink salmon if they use the immediate area for overwintering or spawning.

Project-induced erosion would be minimized by construction methods and design. Project facilities such as pads and roads would be situated on high ground to the extent possible and designed to minimize potential erosion (armoring, wing-walls at bridge abutments, etc. (see Section 2). However, roads, culvert failure, and bridge approaches within river terraces could alter hydrology.

Because most activities and development will occur within the Plan Area, estuarine and marine EFH areas are not likely to be affected.

4A.3.2.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Fish

- At project completion, gravel mines should be converted to fish habitat if practicable and consistent with an approved mine rehabilitation plan and the design of the mine.
- The Nigliq Channel and Ublutuoch River bridges should be constructed so that they span the floodplain terrace(s) in addition to the main channel.
- Ice roads and airstrips should avoid fish overwintering areas where possible, and in all cases maintain fish passage.
- CPAI should perform fish surveys and hydrologic modeling for water bodies at proposed culvert sites. The results of these surveys and modeling should be incorporated into the site-specific designs of culverts.
- CPAI should install bridges or culverts in roadbeds in low-lying areas to ensure fish passage during high water conditions.
- CPAI should continue fish monitoring studies in the Plan Area to ensure that the health of regional and locally important fish stocks is maintained. CPAI's mitigation plan should include remedial measures to be taken should monitoring detect adverse impacts due to the project.
- Instead of installing a culvert battery in Lake L9323, CPAI should avoid the lake and instead use a road alignment to the east (similar to Alternate Access Road 2S that CPAI previously evaluated [CPAI 2002a] in early planning stages of this project); bridges should be used to cross two watercourses east of Lake L9323.
- CPAI should monitor all culverts on a schedule to be approved by the ADF&G to ensure that they are properly maintained and are ensuring access by fish to critical summer spawning and rearing grounds. CPAI will promptly repair any culverts that are not meeting these intended fish passage goals.
- Intake structures specially designed to eliminate the potential for fish being impinged, entrained, or entrapped during withdrawal of water should be used at all fish-bearing water sources.
- CPAI should route roads and pipelines to avoid the 3-mile Fish Creek buffer to the extent practicable.

4A.3.2.5 Alternative A –Effectiveness of Protective Measures for Fish

Stipulations 15, 16, and 20 from the Northeast National Petroleum Reserve-Alaska IAP/EIS are the most likely to have a beneficial effect on arctic fish. Others that may benefit arctic fish include Stipulations 5, 9, 11, 12, and 41. With these stipulations in place, there is an increased probability that (1) spawning and overwintering fish would be unaffected by activities associated with Alternative A, (2) fish passage and streamflows would be maintained, and (3) the effects of accidental fuel spills would be minimized. These stipulations may benefit arctic fish populations. In addition to these stipulations, potential mitigation identified in this EIS could create new fish habitat at gravel mine sites, reduce scouring and erosion concerns at certain bridge crossings, and help reduce siltation of rivers and streams.

4A.3.3 Birds

Impacts to birds associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The operation period includes continued drilling and day-to-day operations and maintenance once production has begun. Site specific nest densities for bird species and species groups (Table 3.3.3-5 and Table 3.3.3-7) were used to estimate the number of nests exposed to each alternative. Gravel footprint acreage and habitat alteration acreage (see Tables 4A.3.1-1, 4A.3.1-2, 4A.3.1-3, 4A.3.1-4, 4B.3.1-1, 4B.3.1-2, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-1, 4C-1.3.1-2, 4C-1.3.1-3, 4C-1.3.1-4, 4C-2.3.1-1, 4C-2.3.1-2, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, 4F.3.1-2) were multiplied by nest densities (Table 3.3.3-5 and Table 3.3.3-7) to estimate the total number of bird nests affected by habitat loss or alteration. In addition waterfowl, loon, ptarmigan and seabird nests lost due to disturbance by air traffic were estimated using a maximum of a 67 % reduction in nests within a 500-meter buffer around each airstrip or helipad. This %age was derived from review of Figures 15 to 17 for greater white-fronted geese in Johnson et al. (2003a). No disturbance affect from the Alpine airstrip was demonstrated for shorebirds or passerines (Johnson et al. 2003a), so no impacts were calculated for these groups. No additional loss due to disturbance from vehicle traffic was calculated because losses within 50 meters of roads were considered sufficient to account for disturbance as well as habitat alteration impacts. Habitat loss due to ice roads was estimated using the average number of acres per year covered by ice roads during construction and operations (Tables 2.4.1-2, 2.4.1-9, 2.4.2-2, 2.4.2-8, 2.4.3-4, 2.4.3-10, 2.4.4-2, 2.4.4-6, and 2.4.4-10). Results of these analyses are presented in Tables 4A.3.3-2, 4A.3.3-4, 4A.3.3-5, 4B.3.3-1, 4B.3.3-3, 4B.3.3-4, 4C-1.3.3-1, 4C-1.3.3-3, 4C-1.3.3-4, 4C-2.3.3-1, 4C-2.3.3-2, 4D.3.3-1, 4D.3.3-2, 4D.3.3-4, 4D.3.3-5, 4D.3.3-6, 4F.3.3-1, 4F.3.3-3. Preferred nesting habitats (Table 3.3.3-6 and Table 3.3.3-8) were also considered in evaluating impacts for bird species or species groups. Oil spills also may directly or indirectly affect birds in the Plan Area. Impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

Before we describe the individual alternatives, there are general patterns of effects that the proposed actions would have on birds and their habitats; these are described under Alternative A for each species or species group and are summarized in Table 4A.3.3-1. In most cases, effects would be localized and no adverse effects to North Slope populations would be expected. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snowdrifting take place when nests are not active. In some cases, nesting sites covered by gravel may have been reused in subsequent years; when this occurs, birds would be displaced to adjacent suitable habitats if available (Troy and Carpenter 1990, Johnson et al. 2003a).

4A.3.3.1 Alternative A – CPAI Development Plan Impacts on Birds

Table 4A.3.3-2 presents the estimated number of nests displaced by habitat loss, alteration and disturbance for CPAI Development Plan Alternative A by bird species and species group.

WATERFOWL AND LOONS

Studies conducted in the CD-3 area found that white-fronted geese, tundra swans, long-tailed ducks, and red-throated loons nested in the area of the proposed production pads and airstrip (Johnson et al. 2003b). White-fronted geese, tundra swans, northern pintails, Pacific loons, and yellow-billed loons nested in the CD-4 area (Burgess et al. 2003a). Studies conducted in the National Petroleum Reserve-Alaska found that white-fronted geese, northern pintails, and long-tailed ducks nested in the CD-5, CD-6, and CD-7 areas (Burgess et al. 2003b). Yellow-billed loons in the National Petroleum Reserve-Alaska portion of the Plan Area are concentrated in the

Fish Creek drainage and are generally not associated with the CD-5 and CD-6 sites (Burgess et al. 2003b). A yellow-billed loon nest was located in a lake northeast of the CD-7 site (Burgess et al. 2003b; ABR, unpublished data). White-fronted geese, king eiders, long-tailed ducks, northern pintails, and Pacific loons nested along the proposed road routes to the CD-5, CD-6, and CD-7 sites (Burgess et al. 2002b, 2003b). No waterfowl or loon nests were reported at the Clover Potential Gravel Source (Burgess et al. 2003b).

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be mined or covered by gravel and lost as potential nesting, brood-rearing, and foraging habitat for waterfowl and loons during the construction of the project. Habitat losses from gravel fill would be long-term. An estimated 9.5 waterfowl nests and 1.2 loon nests would be directly affected by gravel placement (Table 4A.3.3-2). Habitats important to waterfowl and loons that would be covered by gravel are presented in Table 4A.3.3-3. Clover would add aquatic habitat after reclamation that may be suitable for use by waterfowl and loons (Appendix O).

Tundra adjacent to gravel fill would also be affected by snowdrifts, gravel spray, dust fallout, thermokarst, and ponding (Walker et al. 1987b, Walker and Everett 1987, Walker 1996, Auerbach et al. 1997). Snowdrifts or plowed snow that accumulates on tundra adjacent to roads, well pads, and airstrips would cause a temporary loss of waterfowl foraging habitat and would preclude waterfowl nesting if snow persists beyond normal nest initiation dates. Dust deposition and associated early snowmelt can cause early green-up on tundra adjacent to roads, providing foraging habitat available for early-arriving waterfowl (Murphy and Anderson 1993, TERA 1993, Noel et al. 1996). This snow-free band of tundra may be approximately 30 to 100 meters in width with changes in vegetation type within 35 feet and alteration in moisture and thermal regimes out to 164 feet (Hettinger 1992, Auerbach et al. 1997, Klinger et al. 1983,Walker and Everett 1987).

TABLE 4A.3.3-1 SUMMARY OF POTENTIAL EFFECTS OF THE PROPOSED DEVELOPMENT ON BIRD GROUPS

	Waterfowl	Loons	Ptarmigan	Raptors and Owls	Shorebirds	Seabirds	Passerines
Habitat Loss, Alteration or Enhancement							
Loss from gravel placement	N, BR, F, St	N, BR, F, St	N, BR, F, W	N, BR, F	N, BR, F, St	N, BR, F, St	N, BR, F
Loss or gain from dust fallout	Loss- N Gain - F		Loss- N Gain - N, F	Loss- N Gain - F	Loss- N Gain - F	Loss- N Gain - F	Loss- N Gain - F
Temporary loss from ice roads	N, F	N, F	N, F	N, F	N, F	N	N, F
Change from structures	Loss - predator gain	Loss - predator gain	Loss - predator gain	Gain - Perches	Loss - predator gain	Both loss and gain	Both loss and gain
Alteration by garbage resources	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss – N Gain - F	Both loss and gain
Disturbance and Displacement							
Air traffic	Loss - N, BR, F, St	Loss - N, BR, F, St		Loss - N, BR, F, St		Loss - N, BR, F, St	
Vehicle traffic	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W		Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F
Intentional hazing	Loss - N, BR, F, St	Loss - N, BR, F, St				Loss - N, BR, F, St	
Facility noise	Loss - N, BR, F, St	Loss - N, BR, F, St				Loss - N, BR, F, St	
People on pads and tundra	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W	Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, St
Obstruction of Movements							
Roadways	Loss - BR, M	Loss - BR	Loss - BR		Loss - BR	Loss - BR	
Mortality							
Collisions	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W	Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, St
Depredation	Loss - N, BR, M	Loss - N, BR	Loss - N, BR, F, W	Loss - N, BR	Loss - N, BR	Loss - N, BR	Loss - N, BR

Notes:
BR = brood-rearing
F = foraging
M = Molting
N = nesting
St = Staging
W = Winter

TABLE 4A.3.3-2 CPAI ALTERNATIVE A – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Waterfowl											
Greater white-fronted goose	2.1	5.8	0.8	15.9	24.7	4.2	20.0	3.6	0.0	27.8	52.5
Snow goose	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Canada goose	0.0	0.1	0.0	0.1	0.2	0.9	4.8	0.9	0.0	6.6	6.8
Brant	0.2	0.5	0.0	2.0	2.7	0.4	2.1	0.4	0.0	2.9	5.6
Tundra swan	0.1	0.4	0.1	0.4	1.0	0.0	0.0	0.0	0.0	0.0	1.0
Mallard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern shoveler	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Northern pintail	0.2	0.6	0.1	0.3	1.2	0.3	0.4	0.1	0.0	0.8	2.0
Green-winged teal	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.2
Greater scaup	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Lesser scaup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King eider	0.0	0.0	0.0	0.1	0.1	0.4	2.4	0.4	0.0	3.2	3.3
Long-tailed duck	0.2	0.7	0.1	2.0	3.0	0.4	1.4	0.2	0.0	2.0	5.0
Waterfowl Total[b]	**2.8**	**8.5**	**1.2**	**21.0**	**33.5**	**6.7**	**31.2**	**5.6**	**0.0**	**43.5**	**77.0**
Loons											
Red-throated loon	0.1	0.3	0.0	0.8	1.2	0.1	0.3	0.1	0.0	0.5	1.7
Pacific loon	0.2	0.7	0.1	1.3	2.3	0.6	3.1	0.6	0.0	4.3	6.6
Yellow-billed loon	0.1	0.2	0.0	0.4	0.7	0.1	0.3	0.1	0.0	0.5	1.2
Loon Total[b]	**0.4**	**1.2**	**0.2**	**2.5**	**4.3**	**0.8**	**3.8**	**0.8**	**0.0**	**5.4**	**9.7**
Ptarmigan											
Willow ptarmigan	0.3	0.8	0.2	0.4	1.7	0.5	1.4	0.2	0.0	2.1	3.8
Rock ptarmigan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ptarmigan Total[b]	**0.3**	**0.8**	**0.2**	**0.4**	**1.7**	**0.5**	**1.4**	**0.2**	**0.0**	**2.1**	**3.8**
Seabirds											
Parasitic jaeger	0.0	0.1	0.0	0.1	0.2	0.1	0.7	0.1	0.0	0.9	1.1
Long-tailed jaeger	0.0	0.1	0.0	0.0	0.1	0.1	0.3	0.1	0.0	0.5	0.6
Glaucous gull	0.1	0.2	0.0	0.6	0.9	0.4	2.4	0.4	0.0	3.2	4.1
Sabine's gull	0.0	0.1	0.0	0.6	0.7	0.2	0.7	0.1	0.0	1.0	1.7
Arctic tern	0.2	0.6	0.1	1.1	2.0	0.4	2.4	0.4	0.0	3.2	5.2
Seabird Total[b]	**0.3**	**1.1**	**0.2**	**2.4**	**4.0**	**1.1**	**6.5**	**1.2**	**0.0**	**8.8**	**12.8**
Shorebirds											
Black-bellied plover	0.5	2.0	0.4	0.0	2.9	0.9	6.7	1.2	0.0	8.8	11.7
American golden-plover	0.6	2.5	0.5	0.0	3.6	0.9	4.4	0.8	0.0	6.1	9.7
Bar-tailed godwiit	0.1	0.5	0.1	0.0	0.7	0.4	1.7	0.3	0.0	2.4	3.1
Semipalmated sandpiper	5.3	23.2	4.5	0.0	33.0	5.8	38.4	7.1	0.0	51.3	84.3
Baird's sandpiper	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.4	0.4
Pectoral sandpiper	10.0	43.9	8.5	0.0	62.4	10.3	37.3	6.6	0.0	54.2	116.6
Dunlin	0.4	1.5	0.3	0.0	2.2	1.0	5.4	1.0	0.0	7.4	9.6
Stilt sandpiper	0.5	2.0	0.4	0.0	2.9	0.9	6.1	1.1	0.0	8.1	11.0
Buff-breasted sandpiper	0.0	0.0	0.0	0.0	0	0.2	2.7	0.5	0.0	3.4	3.4

TABLE 4A.3.3-2 CPAI ALTERNATIVE A – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE (CONT'D)

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Long-billed dowitcher	0.8	3.4	0.7	0.0	4.9	3.5	17.4	3.1	0.0	24.0	28.9
Red-necked phalarope	2.5	10.9	2.1	0.0	15.5	6.2	19.0	3.3	0.0	28.5	44.0
Red phalarope	1.7	7.5	1.4	0.0	10.6	1.9	9.9	1.8	0.0	13.6	24.2
Shorebird Total[b]	22.2	97.4	18.9	0.0	138.5	31.8	149.6	27.0	0.0	208.4	346.9
Passerines											
Yellow wagtail	0.1	0.5	0.1	0.0	0.7	0.1	1.0	0.2	0.0	1.3	2.0
Savannah sparrow	0.6	2.5	0.5	0.0	3.6	1.6	6.5	1.2	0.0	9.3	12.9
Lapland longspur	10.1	44.4	8.6	0.0	63.1	19.4	86.1	15.6	0.0	121.1	184.2
Common redpoll	0.1	0.5	0.1	0.0	0.7	0.7	4.7	0.9	0.0	6.3	7.0
Passerine Total[b]	**10.9**	**47.8**	**9.3**	**0.0**	**68.0**	**21.8**	**98.3**	**17.9**	**0.0**	**138.0**	**206.0**

Notes:

[a] See Section 4A.3.3 Birds for analysis method

[b] Totals rounded to include birds with <0.1 nests/km^2

Ponding created by gravel structures, ice roads, or snowdrifts may become permanent water bodies that persist from year to year or they may be ephemeral and dry up early during the summer (Walker et al. 1987b, Walker 1996). Ponding may create new nesting, feeding and brood-rearing habitat that may be used by some waterfowl and loons, although nests established on impoundments that drain before hatch had higher depredation rates than nests on natural ponds (Kertell 1993, 1994). Placement and maintenance of culverts in roadways eliminates or mitigates the formation of ponding. Habitat alterations resulting from dust fallout, snow drifting and alteration in moisture and thermal regimes would affect an estimated 39.7 waterfowl nests and 5 loon nests (Table 4A.3.3-2). Ice roads and ice pads built during the winter to support construction and drilling activities would affect habitat for nesting waterfowl by delayed melt and altered surface water flow and reducing the availability of tundra nesting habitat. This loss of habitat would be temporary, and its effect on nesting birds would not last longer than the summer after construction and use of the ice road. Ice road construction would average 210 acres per year affecting an estimated 6.8 waterfowl nests and 1.0 loon nests (Table 4A.3.3-2). Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation, these changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003) and are unlikely to affect wet and aquatic habitats used by waterfowl and loons.

Water withdrawal from permitted water sources for the construction of ice roads could affect nesting, brood-rearing or foraging habitats for waterfowl and loons by altering surface water elevations or water quality resulting in nest sites left far from the water's edge, reduced invertebrate populations due to changes in bottom saturation, or reduced fish populations due to changes in water quality. Water surface elevations increased to above pre-pump levels in all lakes studied due to snowmelt runoff in spring (Baker 2002). Water withdraw has not been shown to result in lowered spring surface water elevations, or significant changes in water quality parameters which could impact invertebrate or fish populations. State of Alaska permitting restrictions regulating the volume of water that may be withdrawn from each lake and recharge of ponds and wetlands by snowmelt runoff in spring has been shown to more than replenish surface water elevations (Rovansek et al. 1996, Burgess et al. 2003b, Baker 2002).

TABLE 4A.3.3-3 CPAI ALTERNATIVE A – SUMMARY OF AFFECTED HABITAT TYPES USED BY WATERFOWL, LOONS AND SEABIRDS

Habitat Types	Colville Delta						NPR-A				
	Acres in Colville River Delta[b]	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (16)			Acres in NPR-A[d]	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (20)	
				Nesting (16)	Brood-rearing (13)	Staging (3)				Nesting (20)	Brood-rearing (15)
Open Nearshore Water	1,162					1	0				
Brackish Water	1,807			2		2	2				
Tapped Lake with Low-water Connection	5,397					1	412				
Tapped Lake with High-water Connection	5,146	1.0	<0.1%	5			7				
Salt Marsh*	4,473	0.5	<0.1%	2	1	1	36				
Tidal Flat*	18,187					1	0				
Salt-killed Tundra*	6,362			5	1	1	0				
Deep Open Water without Island*s	5,650	1.3	<0.1%	4	5		12,386	0.9	<0.1%	1	3
Deep Open Water with Islands or Polygonized Margin*	2,160	8.1	0.4%	12	8	1	9,988	0.3	<0.1%	3	6
Shallow Open Water without Islands	547	1.7	0.3%				1,744	0.2	<0.1%	5	3
Shallow Open Water with Island or Polygonized Margins	155			4	4		2,877	2.3	0.1%	11	7
River or Stream	20,306	7.7	<0.1%			1	1,456	0.7	<0.1%		
Aquatic Sedge Marsh	32						3,037	7.6	0.3%	10	2
Aquatic Sedge with Deep Polygons	3,275	15.3	0.5%	12	3		66				
Aquatic Grass Marsh*	369	1.6	0.4%	2			501			2	
Young Basin Wetland Comple*	0						624	19.1	3.1%	9	3
Old Basin Wetland Comple*x	2						15,673	42.9	0.3%	12	4
Riverine Complex*	0						698	4.1	0.6%	3	1
Dune Complex	0						1,889				
Nonpatterned Wet Meadow	11,162	60.5	0.5%	7	2		5,697	24.5	0.4%	4	
Patterned Wet Meadow	27,969	150.3	0.5%	8	4		19,861	105.1	0.5%	7	1
Moist Sedge-Shrub Meadow	2,927	69.8	2.4%	2			42,071	232.1	0.6%	8	1
Moist Tussock Tundra	525	1.1	0.2%				49,647	581.3	1.2%	3	1
Riverine Low and Tall Shrub**	1,270	1.2	<0.1%				1,803	1.9	0.1%		1
Upland Low and Tall Shrub	419						735				
Upland and Riverine Dwarf Shrub*	0						2,240				
Riverine or Upland Shrub*	6,305	32.9	0.5%	2			0				
Barrens (riverine, eolian, or lacustrine)	20,993	17.3	<0.1%	2			1,552				
Artificial (water, fill, peat road)	38						150				
Total Area	**146,638**	**370.4**	**0.3%**				**175,152**	**1023.0**	**0.6%**		

Notes:

[a] Numbers of species using habitats by life history stage (Johnson et al. 2004). Species included are: greater white-fronted goose, snow goose, Canda goose, brant, tundra swan, northern pintail, green-winged teal, greater scaup, spectacled eider, king eider, long-tailed duck, red-breasted merganser, red-throated loon, Pacific loon, yellow-billed loon, parasitic jaeger, long-tailed jaeger, glaucous gull, Sabine's gull, Arctic tern.

[b] Habitat type mapped for the Colville River Delta (Jorgenson et al. 1997) within the Plan Area boundaries

[c] Total includes gravel for pads and airstrips and area indirectly affected by dust, snowdrifts, and alteration in thermal or moisture regimes (see Table 4A.3.1-2)

[d] Habitat type mapped for the National Petroleum Reserve-Alaska area (Jorgenson et al. 2003a) within the Plan Area boundaries

* Key Wetlands

Under Alternative A, approximately 36 miles of pipeline would be installed for transfer of production oil, gas, and water. New pipelines would be elevated a minimum of 5 feet above the tundra, and pipeline construction would occur during the winter when loons and waterfowl are not present in the Plan Area. Snowdrifts downwind from the pipeline would alter habitat by later melt and potential alteration of surface flow. Elevated pipelines would not be expected to contribute significantly to direct habitat loss, although they would cross areas used by nesting and brood-rearing greater white-fronted geese (Figure 3.3.3.2-2 and Figure 3.3.3.2-3), brant (Figure 3.3.3.2-4 and Figure 3.3.3.2-5), tundra swans (Figure 3.3.3.2-7 and Figure 3.3.3.2-8), long-tailed ducks (Figure 3.3.3.2-14), king eiders (Figure 3.3.3.2-12 and Figure 3.3.3.2-13) and loons (Figure 3.3.3.3-4 and Figure 3.3.3.3-5).

Alternative A includes seven bridges and five culvert batteries to be constructed over several rivers, lakes, and unnamed drainages, the largest of which would span the Nigliq Channel of the Colville River. In the CD-4 area, a road crossing may affect some nesting waterfowl at a lake north of the site where tundra swans (Figure 3.3.3.2-7) and yellow-billed loons have nested.

Disturbance and Displacement

Disturbance related to Alternative A would likely displace some nesting waterfowl and loons near the proposed airstrip at the CD-3 site. Studies at the Alpine Field indicate that greater white-fronted geese may move to adjacent habitats if suitable habitat is available (Johnson et al. 2003a). Disturbance and displacement related to vehicular traffic would affect waterfowl and loons along the proposed road system connecting CD-4 with CD-1. Disturbance related to vehicular traffic would also affect waterfowl and loons along the roadway to the CD-5, CD-6, and CD-7 sites (Figure 3.3.3.2-3). In the CD-5 area, the white-fronted goose is a common nesting species near the site of the proposed road, along with small numbers of ducks, including king eiders (Figure 3.3.3.2-3 and Figure 3.3.3.2-13). Nest densities of waterfowl and loons were 15.3 nests/km^2 in the wetlands in the CD-5 area; in contrast, few waterfowl and loon nests were reported in the CD-6 (2.7 nests/km^2) and CD-7 (4.6 nests/km^2) areas (Table 3.3.3-5) (Burgess et al. 2003b, Johnson et al. 2004). Disturbance due to air traffic would displace an estimated 21.0 waterfowl nests and 2.5 loon nests (Table 4A.3.3-2).

Because gravel will be placed during the winter when waterfowl and loons do not occur on the Arctic Coastal Plain, no waterfowl or loon nests would be disturbed by this activity. Some waterfowl and loons would be disturbed during the summer breeding season by vehicular, aircraft, and boat traffic; noise from equipment on roads or at facilities; and pedestrian traffic. Disturbance by vehicles, equipment activities such as road grading and compaction or aircraft during summer would decrease the numbers of waterfowl nesting, brood-rearing or foraging in areas adjacent to roadways and airstrips (Ward and Stehn 1989, Murphy and Anderson 1993, Johnson et al. 2003a).

On the North Slope, vehicular traffic, including large trucks hauling cranes and other equipment, and road maintenance equipment had greater effects on geese feeding close to roads than on geese feeding farther away (Burgess and Stickney 1992, Murphy et al. 1988, Murphy and Anderson 1993). Disturbances to bird activity occur most often during the pre-nesting period, when birds gather to feed in open areas near roads, and during brood-rearing and fall staging. A small %age of birds may walk, run, or fly to avoid vehicular disturbances (Murphy and Anderson 1993). Disturbance reactions occur most often within 50 meters of roads (Murphy and Anderson 1993). Disturbance from vehicular traffic may affect activity and energy budgets of waterfowl and loons and could have negative impacts on nesting success for some birds by increasing the length of time birds are away from the nest during incubation (Johnson et al. 2003a). Successful tundra swan nests average further from roads than unsuccessful nests (Ritchie and King 2000). Brood-rearing greater white-fronted geese have been found to avoid areas within 200 meters of roads (Murphy and Anderson 1993). Speed limits for vehicular traffic would help to minimize the effects of disturbance, particularly during brood-rearing when birds are flightless.

Noise and visual stimuli associated with helicopter and fixed-wing air traffic would disturb waterfowl and loons near the proposed airstrip at the CD-3 site. The potential for aircrafts to elicit reactions in waterfowl is well documented (Gollop et al. 1974a, Schweinsburg 1974, Ward and Stehn 1989, Derksen et al. 1992, McKechnie and Gladwin 1993, Johnson et al. 2003a). Responses of birds to aircrafts include alert and concealment postures, interruption of foraging behavior, flight, and decreases in nest attendance (Johnson et al. 2003a). While some studies have suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircrafts, others have indicated that both may elicit disturbance reactions (Gollop et al. 1974b, Johnson et al. 2003a). Nesting greater white-fronted geese took more and longer recesses from incubation as the number of airplanes increased - at nest sites closer to the airstrip (Johnson et al. 2003a). Of the various disturbance types, helicopters were the least predictable because they did not have a restricted flight pattern. Incubating greater white-fronted geese and tundra swans reacted more often to fixed-wing aircrafts than to helicopters, although monitored nests were closer to the airstrip than to the helipad. Airplanes and pedestrians elicited the highest rates of response from incubating geese, and vehicles elicited the lowest. These behavioral responses to disturbances did not appear to affect nest outcomes (Johnson et al. 2003a). Greater white-fronted geese shifted nests from areas within 1 km of the airstrip at the Alpine Development Project to areas within 1 to 1.5 km during a period of heavy construction activity (Johnson et al. 2003a). Because brood-rearing birds can move away from disturbances, disturbance may cause further displacement of brood-rearing flocks.

Waterfowl hazing may be necessary in the vicinity of the airstrip to reduce bird-aircraft collision hazards. Hazing would cause additional disturbance, and depending on intensity and timing may cause birds to abandon areas near the airstrip during nesting, foraging and brood-rearing. The area disturbed would be within the 500 meter disturbance buffer used to calculate air traffic disturbance impacts.

Disturbance effects during construction of the Alpine Development Project did not cause changes in nest site selection by tundra swans or yellow-billed loons (Johnson et al. 2003a). The distance of swan nests from the airstrip did not change from pre-construction to construction periods, and nesting success was not negatively affected by proximity of the airstrip. Two swan nests were incubated successfully within 500 meters of the airstrip during construction, and one of these remained 450 meters from the airstrip for at least 6 years, from pre-construction through the operational phase. Analysis of 15 years of tundra swan nest and brood distributions in the Kuparuk Oilfield indicate that there was no significant relationship between the intensity of disturbance and nest or brood densities within 1 km of roads (Anderson and Stickney 2004). Nesting yellow-billed loons also did not exhibit any measurable changes during construction of the Alpine Development Project, but only a few pairs nested in the area and all nests were more than 700 meters from the airstrip.

Other studies have also indicated the potential for noise-related disturbance to affect birds near the noise source. Anderson et al. (1992) reported that most waterfowl experienced no detrimental effects from noise near the GHX at Prudhoe Bay, although pre-nesting Canada geese and nesting spectacled eiders appeared to use areas farther away from the facility noise. Gollop and Davis (1974) reported that feeding behavior of snow geese was adversely affected in the vicinity of an experimental gas compressor noise simulator and that some birds detoured around the experimental disturbance. Johnson et al. (2003a) reported that annual changes in greater white-fronted goose nest distribution reduced the average noise exposure at nest sites around the Alpine Development Project airstrip, but by a small and insignificant amount. Aircraft noise had inconsistent effects on incubation behavior and probably did not affect nesting outcome (Johnson et al. 2003a). Noise levels from helicopters and airplanes at CD-3 are likely to be less than at the Alpine Development Project airstrip because of fewer flights and use by twin-engine planes rather than the noisier four-engine planes (Johnson et al. 2003a).

Obstructions to Movement

In general, the infrastructure associated with Alternative A, including roads and production pads, the airstrip, buildings, elevated pipelines, power lines, bridges, and culverts, should not cause physical obstructions to most movements of waterfowl and loons except during brood-rearing. Usually, birds can easily fly over or around these structures except during brood-rearing. Birds would be most likely to collide with structures during periods of poor visibility such as foggy conditions or at dusk. These structures may present some temporary obstructions to movements of waterfowl and loons during brood-rearing and molting periods when birds are flightless, particularly if traffic levels are high (Murphy and Anderson 1993). However, loons (Kertell 1994) and snow goose broods (Johnson 1998, 2000) have crossed roads in active oilfields, although they initially may have been impeded (Burgess and Ritchie 1991).

Mortality

Some waterfowl and loon mortality would result from collisions with vehicles, elevated pipelines, buildings, or power lines, particularly under poor visibility conditions. Collisions with vehicles was the greatest source of bird mortality, primarily for ptarmigan and passerines, associated with the TAPS, particularly along the Dalton Highway where birds were attracted to roadside areas of early green-up caused by dust shadows (TAPS Owners 2001a). Mortality of a few individual birds would be associated with collisions with aircrafts during takeoff and landing. Mortality of a few individuals or small flocks would be associated with birds that collide with structures such as elevated pipelines, buildings, communications towers, power lines, or bridges. Some waterfowl and loons would be expected to collide with power lines, although collisions would be infrequent (Murphy and Anderson 1993). Collisions with power lines could be minimized by marking lines with bird flight diverters.

Some predators, such as ravens, glaucous gulls, arctic foxes, and bears, may be attracted to areas of human activity where they find human-created (anthropogenic) sources of food and denning or nesting sites (Larson 1960, Eberhardt et al. 1982 Day 1998 Burgess 2000 USFWS 2003b). The availability of anthropogenic food sources, particularly during the winter, may increase winter survival of arctic foxes and contribute to increases in the arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Increased levels of depredation resulting from elevated numbers of predators could adversely affect nesting and brood-rearing success for waterfowl and loons. Arctic foxes, glaucous gulls, and common ravens prey on eggs and young of waterfowl and loons (Murphy and Anderson 1993, Noel et al. 2002b, Rodrigues 2002, Johnson et al. 2003a, USFWS 2003b). The NRC, in their review of the cumulative effects of oilfield development on the North Slope (NRC 2003), concluded ". . . high predation rates have reduced the reproductive success of some bird species in industrial areas to the extent that, at least in some years, reproduction is insufficient to balance mortality." At a more recent workshop on human influences on predators of ground-nesting birds on the North Slope, sponsored by the USFWS, participants concluded that common ravens have increased in response to developments, but that increases in arctic fox and glaucous gull populations were uncertain (USFWS 2003b). There was further uncertainty in the link between increased predator populations and resulting population level impacts to ground-nesting birds. The numbers of foxes and most avian predators in the Alpine Field did not appear to increase during construction of the project, with the exception of common ravens, which nested on buildings at the Alpine Field (Johnson et al. 2003a). There was no indication that the presence of this pair of ravens caused an increase in nest depredation within about 2 miles of the Alpine Field (Johnson et al. 2003a). There is direct evidence, however, that common ravens nesting at Alpine Field, Nuiqsut and Meltwater reduced nesting success up to 26 miles away at the Anachlik nesting colony by as much as 80 % (J. Helmericks 2004, pers. comm.). Predator observations throughout the Plan Area documented jaegers and glaucous gulls as the most common nest predators followed by common ravens (Johnson et al. 2004). Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

Addition of overhead power lines may increase mortality to waterfowl and loon nests by providing raptors and common ravens with perches that could enhance their ability to locate and depredate nests. In recent years, The NSB has installed predator-proof dumpsters at camps and implemented refuse-handling techniques to minimize the attraction of predators to the landfill. Oilfield workers continually undergo training (and receive notifications from the CPAI Environmental group during the summer) to increase their awareness of the problems associated with feeding wildlife. These practices would minimize impacts related to increased levels of depredation and would be continued in the ongoing development of the ASDP.

Researchers conducting studies on bird nesting density and success may inadvertently attract predators to nests and broods (Bart 1977, Götmark 1992, Strang 1980). Birds that are flushed from their nests during surveys are more susceptible to nest depredation. Ongoing activities by researchers would cause some mortality to waterfowl and loon eggs and chicks. Mitigation plans that reduce human activity near nesting eiders were effective in reducing eider mortality during the nesting period (Johnson et al. 1987).

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during the construction period because of reduced traffic, but would be greatest during the operation period over the life of the project. Ice roads and ice pads built during the winter to support drilling activities would affect habitat for nesting waterfowl by delayed melt and altered surface water flow and reducing the availability of tundra nesting habitat. Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation. These changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and are unlikely to affect wet and aquatic habitats used by waterfowl and loons.

Disturbance and Displacement

Disturbance and displacement from aircraft and vehicle traffic and facility noise would be similar to during the construction phase. Disturbance would be reduced from the construction phase because of reduced levels of both air and ground traffic. Disturbance types, along with the general reactions of waterfowl and loons, were discussed under the Construction Period heading.

Boat traffic during oil spill drills, equipment checks, and boom deployment, especially airboat traffic, may be disruptive to pre-nesting, nesting, foraging, brood-rearing, and staging waterfowl and loons. Long-tailed ducks in Beaufort Sea lagoons did not show effects of disturbance by either seismic exploration or boat traffic on movement, habitat use, or foraging (Flint et al. 2003). Boat traffic will cause disturbance to large flocks of brood-rearing and staging flocks of geese and tundra swans within the Colville River Delta. These activities are expected to be of short duration and would probably cause temporary displacement.

Obstructions to Movement

Obstructions to movements from roadways would continue into the operation period and would be similar to the construction phase. Obstruction would be reduced from the construction phase because of reduced levels of traffic.

Mortality

Some waterfowl and loon mortality would result from collisions with aircraft, vehicles, elevated pipelines, buildings, communications towers, power lines, or bridges, particularly under conditions of poor visibility. Collisions would generally be limited to a few individuals, although small flocks could collide with power lines. Collision frequency with vehicles and aircrafts would be expected to be less than during construction because of decreased traffic levels. Collision impacts with structures and power lines would be greatest during project operation over the life of the field.

Waterfowl nesting success in the Plan Area was generally low (approximately 26 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for waterfowl and loons. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as long-tailed ducks (Mallek et al. 2003) and red-throated loons (Larned et al. 2003); and to colonial nesting species which concentrate in specific locations providing an abundant and predictable protein source. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

PTARMIGAN

Ptarmigan nest in the areas proposed for development under Alternative A. Several ptarmigan nests were reported during ground searches for nesting birds near the area proposed for the airstrip and production pad in the CD-3 site (Johnson et al. 2003b). At the CD-4 site, ptarmigan nests were reported near the proposed site of the production pad and access road to CD-1 (Burgess et al. 2003a). At the CD-5 site, ptarmigan nested near the access road south of the proposed pad (Burgess et al. 2003b). At the CD-6 site, a ptarmigan nested near the proposed site of the production pad. The closest ptarmigan nest to proposed infrastructure at the CD-7 site was north of the proposed access road. Gravel placement at the CD-3, CD-4, CD-5, and CD-6 sites could displace some nesting ptarmigan and birds probably would nest in adjacent areas.

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be covered by gravel and lost as potential nesting, brood-rearing, and foraging habitat for ptarmigan. An estimated 0.8 willow ptarmigan nest would be affected by gravel placement and mining (Table 4A.3.3-2).

Tundra adjacent to gravel fill would also be affected by snowdrifts, gravel spray, dust fallout, thermokarst, and ponding. Snowdrifts or plowed snow would cause a loss of ptarmigan nesting and foraging habitat, while dustfall and early meltout near roads would provide foraging habitat during early spring. As with waterfowl, ptarmigan make use of forage in early green-up areas next to roadways created by dust deposition. An estimated 2.2 willow ptarmigan nests would be affected by habitat alteration (Table 4A.3.3-2). Ptarmigan would use some structures, such as pipelines, for perches.

Ice roads and ice pads built during the winter would reduce the availability of habitat for nesting ptarmigan due to delayed melting and altered surface-water flow affecting an estimated 0.4 willow ptarmigan nests (Table 4A.3.3-2).

Disturbance and Displacement

Few studies have been conducted to determine the effects of disturbances on nesting or brood-rearing ptarmigan. Ptarmigan sit very tightly during incubation, and disturbance by vehicular and air traffic, machinery, and facility noise would have little impact on nesting ptarmigan. Pedestrian traffic would also have little impact on nesting ptarmigan, because low nesting densities will limit the effect of disturbance. Some ptarmigan may remain on the Arctic Coastal Plain during winter, and a few birds would be disturbed or displaced during winter construction. Ptarmigan would be attracted to gravel fill sites because they provide grit and dust for bathing. An estimated 0.4 ptarmigan nests would be displaced due to disturbance from air traffic in the Colville River Delta (Table 4A.3.3-2).

Obstructions to Movement

Movements of ptarmigan are unlikely to be affected by gravel placement for roads, well pads, and airstrips because ptarmigan can walk or fly over or around such structures. Likewise, buildings, pipelines, and bridges should pose little obstruction to movements of ptarmigan.

Mortality

Ptarmigan could suffer mortality from collisions with vehicular traffic, machinery, buildings, bridges, and pipelines during the construction phase of the development. This is a likely cause of mortality for ptarmigan in the early spring when they are drawn to roadways by early green-up and access to grit. Ptarmigan were among the species of birds most often struck by traffic during the TAPS project, although the number of birds lost was likely low compared to area populations (TAPS Owners 2001a). Five ptarmigan were killed in a single incident by a collision with an aircraft on the Kuparuk airstrip in early spring. This is the only reported mortality to ptarmigan since 1987.

Any increase in predator populations would result in increased adult mortality and decreased reproductive success for ptarmigan. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which aggregate in predictable locations year to year, and with low total population sizes.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation.

Disturbance and Displacement

Little disturbance or displacement of ptarmigan is expected, because this species appears to tolerate human activity. Potential disturbance would be lower during project operation than during construction because traffic levels would be reduced.

Obstructions to Movement

Obstructions to the movements of ptarmigan would be similar to those during construction but would be reduced because of reduced traffic levels during project operation.

Mortality

Collisions with vehicles in the proposed development could cause a few ptarmigan deaths. Losses are most likely during spring when ptarmigan are attracted to areas of early green-up near roads and during the summer when more ptarmigan are likely to be present in the Plan Area. Reduced speed limits along roads, particularly during periods of poor visibility, may help to minimize the potential for collisions of ptarmigan with vehicles. The potential for mortality of ptarmigan from collisions with elevated pipelines, bridges, power lines, and buildings would be limited to a small number of individuals.

Ptarmigan nesting success in the Plan Area was 50 % (Johnson et al. 2004). Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would increase mortality of adult ptarmigan, eggs, and chicks. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

RAPTORS AND OWLS

Raptors and owls are generally uncommon visitors and occasional nesters in the Plan Area. Potential nesting species on the Arctic Coastal Plain include peregrine falcon, rough-legged hawk, northern harrier, short-eared owl, and snowy owl. In the Plan Area, a peregrine falcon nest was reported on a bank of Fish Creek approximately 3.5 miles from the CD-7 site (Figure 3.3.3.5-1) (Burgess et al. 2003b). Northern harrier and short-eared-owl nests have been found at CD-4 (Burgess et al. 2003a). These species and other raptors that occur in the area are occasionally observed foraging and passing through during migration. Juvenile golden eagles use the Arctic Coastal Plain for foraging and are often observed during the caribou calving period. Golden eagles do not nest in the Plan Area.

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Habitat loss and disturbance resulting from winter mining and gravel placement for the proposed development is unlikely to affect the few raptors and owls occurring in the Plan Area. Snowdrifts or plowed snow would cause a temporary loss of nesting habitat for northern harriers, short-eared owls, and snowy owls. Short-eared owls, snowy owls, and northern harriers are attracted by aggregations of waterfowl and ptarmigan in green-up areas created by dustfall and early meltout near roads.

Towers, pipelines, and power lines would provide perches, which would improve foraging efficiency, and would provide potential nesting habitat for raptors. Although rough-legged hawks and peregrine falcons use abandoned infrastructure for nesting, it is unlikely that they would nest in active oilfield areas. There have been no reported raptor nests in the Prudhoe Bay oilfield area.

Disturbance and Displacement

The small numbers of raptors and owls present in the Plan Area are not likely to be disturbed during nesting by the proposed development. Peregrine falcons forage on juvenile and staging shorebirds in the lower Colville River Delta, disturbance by air traffic during late summer would potentially effect their foraging efficiency.

Obstructions to Movement

Gravel roads, buildings, pipelines, power lines, and bridges are unlikely to obstruct movements of raptors.

Mortality

It is unlikely that the small number of birds that occur in the Plan Area would suffer any mortality from collisions with vehicular traffic, air traffic, buildings, bridges, or pipelines. Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would decrease productivity of nesting raptors and owls. Because so few raptors and owls nesting in the Plan Area effects would be minor. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat alteration from dust fallout would continue during project operation and would continue to attract raptors to aggregations of waterfowl and ptarmigan next to the roadways. Towers, pipelines, and power lines would continue to provide perches, which would improve foraging efficiency for raptors.

Disturbance and Displacement

The small numbers of raptors and owls present in the Plan Area would not be likely to be disturbed by the proposed development during nesting. Airboat-based oil-spill drills, equipment checks, and boom placement along river channels may disturb raptors or disrupt their foraging, however these activities will be located north of known nesting locations. Nesting occurs along riverbanks south of the proposed development. Any boat-based traffic in these nesting areas may disturb nesting raptors. Air traffic in the lower Colville River Delta may interrupt peregrine falcon foraging on juvenile and staging shorebirds.

Obstructions to Movement

Gravel roads, buildings, pipelines, power lines, and bridges are unlikely to obstruct raptor movements.

Mortality

It is unlikely that the small number of birds that occur in the Plan Area would suffer any mortality from collisions with vehicular traffic, air traffic, buildings, bridges, or pipelines. Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would decrease productivity of nesting raptors and owls. Because so few raptors and owls nest in the Plan Area, effects would be minor. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

SHOREBIRDS

The following shorebird species may be most affected by the proposed developments in Alternative A, based on abundance of more than 2 nests/km^2 as presented in Table 3.3.3-7:

- Colville River Delta – pectoral sandpiper, semipalmated sandpiper, red-necked phalarope, red phalarope, long-billed dowitcher, and American golden-plover
- CD-5 – pectoral sandpiper, red phalarope, long-billed dowitcher, semipalmated sandpiper, stilt sandpiper, red-necked phalarope
- CD-6 – pectoral sandpiper, semipalmated sandpiper, long-billed dowitcher
- CD-7 – pectoral sandpiper, semipalmated sandpiper, long-billed dowitcher
- The National Petroleum Reserve-Alaska Area – semipalmated sandpiper, pectoral sandpiper, red-necked phalarope, long-billed dowitcher, red phalarope

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Under Alternative A, winter mining and placement of gravel during construction would account for most of the direct habitat loss. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting, brood-rearing, foraging and staging habitat for shorebirds during the construction of the project. Habitat losses from gravel fill would be long-term. An estimated 54.0 shorebird nests, including 20.3 pectoral sandpiper and 11.1 semipalmated sandpiper nests, would be affected by gravel fill and mining.

Dust shadows leading to early snowmelt and green-up may also increase nesting and foraging habitat availability for shorebirds. Construction of gravel roads may result in alteration of habitat by the development of ponds and thermokarsting of soils at the edges of roads and pads. For species such as dunlin, plovers, and buff-breasted sandpipers that generally prefer drier habitat types (Derksen et al. 1981, Lanctot and Laredo 1994; Troy 2000), these impacts would result in a small amount of habitat loss. For species such as pectoral sandpipers, long-billed dowitcher, stilt sandpiper and phalaropes (Derksen et al. 1981, Troy 2000) that prefer to nest and rear young near water, these alterations would result in a small increase in habitat. Alterations in habitats near roads, including interruption of surface flow and thermokarst, create very wet and emergent tundra that is preferred by red-necked phalaropes (Rodrigues 1992, Noel et al. 1996).

Habitats important to nesting and brood-rearing shorebirds that would be lost or altered by gravel placement in the Colville River Delta include Aquatic Sedge with Deep Polygons (0.5 % of available habitat altered), Nonpatterned Wet Meadow (0.5 % of habitat altered), and Patterned Wet Meadow (0.5 % of habitat altered). Habitats important to nesting and brood-rearing shorebirds that would be affected by gravel placement in the

National Petroleum Reserve-Alaska area include Aquatic Sedge Marsh (0.3 % of available habitat altered) and Old Basin Wetland Complex (0.3 % of habitat altered). Avoidance of key wetland habitats, and preferential placement of facilities on moist and dry habitat types results in a disproportionate impact on these habitats preferred by dunlins, plovers and buff-breasted sandpipers. Under CPAI Alternative A, in the Colville River Delta 19 % of habitat impacts affect moist habitats and in the National Petroleum Reserve-Alaska portion of the Plan Area 79 % of habitat impacts affect moist habitats (Moist Sedge-Shrub Meadow and Moist Tussock Tundra). Gravel mining would result in a loss of tundra habitats while the mine sites are active and creation of aquatic habitat after reclamation (Appendix O).

Ice roads and ice pads built during the winter to support construction and drilling activities would affect habitat for nesting shorebirds by delayed melt and altered surface water flow and reduced availability of nesting habitat on the tundra. Shorebirds should be into incubation before the ice roads melt and would be displaced by ice roads. The average of 210 acres of ice road would displace an estimated 45.9 shorebird nests (Table 4A.3.3-2). Water withdrawal for construction of ice roads would not affect nesting shorebirds. Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation; these changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and may decrease habitat quality for nesting shorebirds by compression of tussocks and standing dead vegetation.

Disturbance and Displacement

Winter construction activities would not disturb shorebirds. Increased human activity along roads (primarily vehicles), at production pads (vehicles and pedestrians), and at the CD-3 airstrip (fixed-wing aircraft, vehicles, and pedestrians) to facilitate construction of infrastructure at the production pads during the summer would potentially disturb or displace some shorebirds.

Construction activities on the production pads, vehicle traffic along the roads, and aircraft activities at CD-3 would result in localized high noise levels. Johnson et al. (2003a) did not find that nesting shorebirds moved farther from the Alpine Field during summer construction activities. Semipalmated sandpipers nested significantly more frequently in areas closer to the Alpine airstrip than in areas farther from the airstrip, but annual variability in nest locations was high. Pectoral sandpipers and red-necked phalaropes nested slightly more often near the airstrip than away from it. Other North Slope studies designed to assess the impacts of disturbance from oil and gas activities on nesting birds have reported mixed results. In the Prudhoe Bay field, Troy (1988) found that nesting semipalmated sandpipers and dunlin were less common adjacent to spine roads than away from roads, but there was little difference in numbers of these species near less-trafficked access roads and roadless areas. In the same study, red-necked phalaropes were more common near roads than away from roads.

Because of the proximity of CD-3 to the salt marshes and coastal silt barrens of the Colville River Delta, shorebirds gathering in coastal areas of the Colville River Delta to build fat reserves for migration (Andres 1994) may be displaced from feeding areas near CD-3 in response to increased human activities and noise levels during construction. Primary species included in post-breeding foraging flocks of shorebirds include dunlin, semipalmated sandpipers, red-necked phalaropes, western sandpipers, and pectoral sandpipers (Andres 1994). A total of 37 acres of Barrens, River or Stream and Salt-killed Tundra habitats used by staging shorebirds are within 500 meters of the airstrip at CD-3. Based on a staging period density of 150 shorebirds/km^2 in the lower delta (Andres 1994) an estimated 313 shorebirds, primarily dunlin, would potentially be disturbed by air traffic within 500 meters of the CD-3 airstrip. Displacement of large flocks of shorebirds from these important and limited habitats could adversely affect the migrant shorebird population passing through the Delta (Andres 1994).

Obstructions to Movements

The construction of gravel roads and pads is not anticipated to obstruct shorebird movements because most birds can fly. However, shorebird broods attempting to move from nesting sites to brood-rearing areas may be obstructed by the presence of roads and pads and traffic volumes associated with construction activities.

Mortality

A few individual shorebirds and small flocks may die if they fly into infrastructure on production pads, pipelines, or power lines or if they collide with vehicles or aircraft as they fly or walk (with broods) across roads, pads, or airstrips. Potential mortality from vehicles may be mitigated by slower speed limits on roads during brood-rearing periods. Addition of overhead power lines between CD-6 and CD-7 may increase mortality to shorebirds and their nests by providing raptors and common ravens with perches that could enhance their ability to locate and depredate incubating individuals and nests. Shorebirds may also collide with power lines. More than 15 red phalaropes collided with power lines in Barrow during a 2-day period in fall 2003 (R. Suydam, NSB, pers. comm.).

Overall shorebird nesting success in the Plan Area was generally high, 60 % in 2003 (Johnson et al. 2004) and 64 % in 2002 (Burgess et al 2003b), but nest success was variable among species ranging from 86 % for long-billed dowitchers to 26 % for black-bellied plovers (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers (Lanctot and Laredo 1994) and dunlin.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during the construction period because of reduced traffic, but would be greatest during the operation period for the life of the project. Nesting habitat would be lost to shorebirds during the operation period as a result of annual ice road construction. Impacts from ice road construction would be similar to those discussed for the construction period. However, if ice roads are placed in the same location annually, impacts to the tundra could be longer-term.

Habitat alterations from use of low-ground-pressure vehicles during summer or winter during the operation period are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and may decrease habitat quality for nesting shorebirds by compression of tussocks and standing dead vegetation. Impacts from habitat alterations during operations would be detrimental to some shorebird species but may be beneficial to others. Phalaropes have been reported nesting in association with thermokarst.

Disturbance and Displacement

Disturbance and displacement of shorebirds during operation activities would be similar to that during construction activities except that most human activities and noise levels would be lower during operations. Disturbances related to the Alpine Development Project facilities did not appear to effect shorebird nesting densities near the facility (Johnson et al. 2003a). In addition, oil-spill drills and boom placement will cause additional disturbance along the river channels and in the Delta. Noise from airboat traffic would temporarily displace shorebirds. Air traffic in the lower Colville River Delta associated with CD-3 would disturb an estimated 313 staging shorebirds.

Obstructions to Movements

Obstructions to movements would be similar to that during the construction phase, although lower traffic levels may reduce obstruction to shorebirds with broods.

Mortality

Direct mortality of a few individuals or small flocks of shorebirds would occur during operational activities from collisions with structures or vehicles. Shorebirds may also collide with power lines. More than 15 red phalaropes collided with power lines in Barrow during a 2-day period in fall 2003 (R. Suydam, NSB, pers. comm.). Any increase in predator populations would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers (Lanctot and Laredo 1994) and dunlin.

SEABIRDS (GULLS, JAEGERS, AND TERNS)

The following seabirds may be affected by the proposed developments in Alternative A, based on abundance of more than or equal to 0.3 nests/km^2 as presented in Table 3.3.3-5:

- CD-3— arctic tern, Sabine’s gull, glaucous gull
- CD-4—arctic tern, long-tailed jaeger
- CD-5—glaucous gull, arctic tern
- CD-6—no seabirds
- CD-7—Sabine’s gull, arctic tern
- The National Petroleum Reserve-Alaska Area—arctic tern, glaucous gull

CONSTRUCTION PERIOD

Habitat Loss, Alteration, and Enhancement

Winter mining and placement of gravel during construction would account for most of the direct or indirect habitat loss or alteration for Alternative A. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting, brood-rearing, and foraging habitat for seabirds, primarily gulls, jaegers, and arctic tern. Habitat losses from gravel fill would be long-term. An estimated 1.4 seabird nests would be affected by gravel placement (Table 4A.3.3-2). Habitats important to seabirds that would be covered by gravel include Aquatic Sedge with Deep Polygons, and Patterned and Nonpatterned Wet Meadows.

Loss of seabird habitat under Alternative A would be similar to that described above for waterfowl and loons. Use of areas near gravel roads, pads, and airstrips by seabirds is less well documented than for waterfowl and loons, and some of the effects of habitat alterations associated with gravel placement, such as snowdrifts, dust fallout, thermokarst, and ponding, may be less likely to affect seabirds than waterfowl. Ponded areas would be attractive to seabirds, particularly glaucous and Sabine’s gulls and arctic terns, that nest on islands or along shorelines of lakes and other wetlands. An estimated 7.6 seabird nests would be affected by habitat alteration and 1.4 seabird nests would be affected by ice roads (Table 4A.3.3-2). Water withdraw for ice road construction would not affect seabird habitat because spring snowmelt runoff will restore water surface levels.

Disturbance and Displacement

Disturbance related to Alternative A would displace an estimated 2.4 seabird nests near the proposed airstrip at CD-3. Seabirds may be particularly responsive to pedestrian traffic. Incubating glaucous gulls, Sabine’s gulls, arctic terns, and jaegers leave the nest with the approach of humans on foot in the same manner as for approaching mammalian or avian predators. These species use mobbing activity to try to discourage such intrusion by humans or predators. Incubation recesses caused by pedestrian traffic would make seabird nests more susceptible to depredation (Noel et al. 2002b).

Glaucous gulls are attracted to gravel structures and associated facilities and human activity because of the potential availability of anthropogenic sources of food. Glaucous gulls that nest in the project area could forage at the landfill in Nuiqsut. Glaucous gulls could key into human-related disturbances to nesting waterfowl that leave nests unattended, allowing gulls to feed on the eggs (Noel et al. 2002b). This attraction can be minimized by implementing and monitoring the proper handling of refuse in approved dumpsters and by providing workers with training on the problems associated with feeding wildlife.

Obstructions to Movement

Most movements by seabirds are not likely to be obstructed during construction of the proposed development under Alternative A. Brood-rearing seabirds may have difficulty crossing roadways and gravel airstrips.

Mortality

A few seabirds could die from collisions with vehicles along roadways. Glaucous gulls, in particular, would occasionally be struck by vehicles along roadways. Seabirds, especially gulls, are also particularly vulnerable to collisions with aircraft, and a few gulls would be expected to collide with aircraft. One glaucous gull has been killed by colliding with an aircraft since 1987 at the Kuparuk Oilfield airstrip (C. Rea, CPAI 2004, pers. comm.). Mortality from collisions with buildings, pipelines, power lines, or communication towers is also possible; however, that is expected to be limited to a few individual birds.

The potential for increased levels of depredation to affect seabird egg and chick mortality may be lower than that described for waterfowl, because seabirds at nest sites and with broods are generally aggressive toward predators. Seabird mobbing behaviors would reduce mortality by deterring predators. Any increase in predator populations, however, could result in decreased reproductive success for seabirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003).

OPERATION PERIOD

Habitat Loss, Alteration, and Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during project construction because of reduced traffic, but would be greatest during operations over the life of the project.

Disturbance and Displacement

Disturbance and displacement from aircraft, vehicle and pedestrian traffic, and facility noise would be similar to that during project construction. Disturbance would be reduced because of reduced levels of both air and ground traffic. Seabirds may be either disturbed and displaced by or attracted to airboat-based spill drill, equipment check, and boom placement activities.

Obstructions to Movement

Most seabird movements would not be obstructed by the proposed development. Structures may present some temporary obstructions to movements of seabirds during brood-rearing, particularly if traffic levels are high.

Mortality

Some seabird mortality, limited to a few individuals, may be related to development under Alternative A. Glaucous gulls, in particular, would occasionally be struck by vehicles along roadways. Traffic levels are expected to be less during project operation than during construction, which would reduce potential mortality to seabirds from collisions. Seabirds, especially gulls, are also particularly vulnerable to collisions with aircraft and a few gulls would be expected to collide with aircraft. Mortality from collisions with buildings, pipelines, power lines, or communication towers are also possible; however these are expected to be limited to a few individual birds. Any increase in predator populations, however, could result in decreased reproductive success for seabirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003). Biologists may cause additional mortality during intensive nest search activities (Noel et al. 2002b). This disturbance which flushes birds from nests would be beneficial to glaucous gulls and arctic foxes, which may key into these activities to increase their foraging efficiency.

PASSERINES

The following passerine species may be may be most affected by the proposed developments in Alternative A, based on abundance of more than 1 nests/km^2 or occurrence of common ravens in Table 3.3.3-7 and Section 3.3.3.8 Passerines – Plan Area:

- Colville River Delta – Lapland longspur, Savannah sparrow, common raven
- CD-5 – Lapland longspur
- CD-6 – Lapland longspur
- CD-7 – Lapland longspur, Savannah sparrow
- The National Petroleum Reserve-Alaska Area – Lapland longspur, Savannah sparrow, common redpoll

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting and foraging habitat for passerines. Habitat losses from gravel fill would be long-term. An estimated 32.7 passerine nests, primarily Lapland longspur nests, would be affected by habitat loss due to gravel placement. Habitats used by passerines that would be lost or altered by gravel placement in the Plan Area include Moist Sedge-Shrub Meadow (2.4 % of habitat in the Colville River Delta; 0.6 % of habitat altered in the National Petroleum Reserve-Alaska), Moist Tussock Tundra (0.2 % in the Colville River Delta; 1.2 % altered in the National Petroleum Reserve-Alaska), Riparian Low and Tall Shrub (0.1 % altered in the National Petroleum Reserve-Alaska), and Riverine or Upland Shrub (0.5 % in the Colville River Delta). Removal of gravel from the ASRC and Clover gravel sites would result in loss of tundra habitat and creation of aquatic habitats when the gravel sites are reclaimed (Appendix O). Structures such as towers, buildings, and VSMs for pipeline support would provide additional nesting habitat for common ravens and snow buntings.

Development of ponds and thermokarsting of soils caused by gravel placement would negatively alter habitat for passerine species. An estimated 146.1 passerine nests, primarily Lapland longspur, would be affected by habitat alteration due to gravel fill (Table 4A.3.3-2).

The construction of ice roads to facilitate gravel road, pad, and pipeline construction would result in a temporary loss of nesting habitat because ice roads would melt later than surrounding areas, and passerines likely would be well into incubation before the ice roads melted. An average of 210 acres of ice roads per year would affect an estimated 27.2 passerine nests (Table 4A.3.3-2). Construction of ice roads also may temporarily disturb underlying vegetation and soils, reducing habitat quality for one or two additional nesting seasons. Of particular importance to passerines that prefer willow and other tall shrub habitat would be stream crossings where tall shrubs may be damaged by compacted ice (McKendrick 2000a).

Disturbance and Displacement

Winter construction activities would not disturb or displace most passerines. Common ravens are the only resident passerine species on the North Slope. They may be attracted to construction activities by access to human food, shelter from wind, and access to warm air vents.

During the spring and summer, increased human activity along roads (primarily vehicles), at production pads (vehicles and pedestrians), and at the CD-3 airstrip (fixed-wing aircraft, vehicles, and pedestrians) to facilitate summer construction of pad infrastructure may disturb or displace some passerines, primarily Lapland longspurs, which are the most abundant nesters.

Passerine nests were not displaced from the area around an airstrip at the Alpine Development Project (Johnson et al. 2003a). Lapland longspurs nested in higher densities near an active Alpine airstrip than they did away from the airstrip, although the trend was not significant. Other passerines nested in densities too low to evaluate (Johnson et al. 2003a). See other species group descriptions for a discussion of the range of responses to aircraft noise.

Obstructions to Movements

The construction of gravel roads and pads is not anticipated to obstruct movements of passerines because birds can fly and brood-rearing passerines raise their young in the nest until they are capable of flight.

Mortality

A few individual passerines may die if they fly into production pads, pipelines, buildings, or power lines or if they collide with vehicles as they fly across roads. Towers and building may provide nest sites and perching habitat for common ravens, which may increase nest depredation among tundra-nesting passerines (Johnson et al. 2003a, Murphy and Anderson 1993).

Nesting success for passerines averaged 68 % in the Plan Area (Johnson et al. 2004). Construction of oil development facilities may result in an increase in predator species such as foxes, bears, glaucous gulls, and common ravens. Any increase in predator populations could result in decreased reproductive success for passerines. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining. Biologists may cause additional mortality during intensive nest search activities (Noel et al. 2002b). This disturbance which flushes birds from nests would be beneficial to glaucous gulls and arctic foxes, which may key into these activities to increase their foraging efficiency.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Impacts from ice road construction would be similar to those discussed for construction. However, if ice roads are placed in the same location annually, impacts to the tundra and tall shrubs could be longer-term. Habitat alterations during the operation period may include changes in tundra vegetation from use of low-ground-pressure vehicles during summer or winter. Impacts from habitat alterations during operations would be similar to those on other bird species.

Addition of towers, buildings, and pipelines enhances nesting habitat for common ravens and snow buntings. Common ravens have increased in the Plan Area from a single pair in the late 1950s to about 20 individuals in 2003 (Helmericks 2004). Long-term storage of oilfield equipment provides nesting habitat for snow buntings in the Prudhoe Bay Oilfield, and construction of new facilities on production pads provides nesting habitat for common ravens.

Disturbance and Displacement

Disturbance and displacement of passerines during operational activities would probably have little to no impact on passerines. These activities did not appear to disrupt nesting at the Alpine Development Project during construction, and levels of most human activities are expected to be lower during operations (Johnson et al. 2003a).

Obstructions to Movements

Obstructions to movements would be the same during the operation phase as during the construction phase.

Mortality

Direct mortality of a few passerines would occur during operational activities as a result of collisions with infrastructure or vehicles. An increase in common ravens or other predators as a result of oilfield infrastructure could result in low-level increases of passerine mortality during nesting. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds. Researchers may cause nest success to decrease by disturbance of nesting birds thereby increasing depredation.

ABANDONMENT AND REHABILITATION

The impacts of abandonment and rehabilitation on birds would be similar in many respects to that incurred by construction activity. Activities that occur in the winter would cause little disturbance or displacement, because most species are absent from the area during the winter. However, ice roads may be delayed in melting compared to surrounding tundra, and impoundments of water may be caused by the persistence of ice roads after the snow had melted off the surrounding tundra. Delay in the melting of ice roads compared to the surrounding tundra could cause either complete loss of nesting habitat for a season, or compaction of vegetation, which would reduce the quality of the nesting habitat for that nesting season. Such impacts would only affect nesting in the summer following ice road use, and the impacts would be minor. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to birds similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips are not revegetated, they would remain lost habitat for birds. If they are revegetated without removing the gravel, the habitat would not return to its current utility for most birds of the area. If gravel is removed, habitat similar to that currently existing in the area could be created and used by birds, though the precise mix of rehabilitated habitat types would likely not be the same (Kidd et al., 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal. Fine particles of foam that may not be removed from the environment could be ingested by some birds incidentally; depending on the material’s toxicity and the amount ingested, this could cause mortality, though the numbers are likely to be very small. Overall impacts of abandonment and rehabilitation activities would be localized with no adverse impacts to North Slope populations expected.

4A.3.3.2 Alternative A – Full-Field Development Scenario Impacts on Birds

Under the FFD scenario for Alternative A, the mechanisms associated with impacts related to habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the three facility group areas would be the same as those described under Alternative A for the ASDP. Under Alternative A of the FFD, roads would link all production pads, except for four pads in the lower Colville River Delta and the HP-22 pad in the Kalikpik-Kogru Rivers Facility Group, to processing facilities and to the existing Alpine Development Project facilities. Airstrips would be constructed at the production pads in the lower Colville River Delta and at HP-22 in the Kalikpik-Kogru Rivers Facility Group for maintenance and operational support. Hypothetical development summarized by three facility groups, Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers, would be in addition to the development proposed under Alternative A of the ASDP, and the potential impacts described below would be in addition to those described under Alternative A for the ASDP. The effects of FFD on species within the various bird groupings would depend on the location and extent of development in specific locations within each area. Potential impacts might be less well understood for some portions of the ASDP area because less intense study has occurred.

COLVILLE RIVER DELTA FACILITY GROUP

No roads are hypothesized in this part of the Plan Area. Pipelines would be constructed over several major watercourses including the Elaktoveach Channel, Kupigruak Channel, Tamayayak Channel, and the main stem of the Colville River. In-stream construction activities at these water bodies would have the potential to cause impacts as described in Section 4A.3.3.1.

A summary of the essential numbers of bird nests affected by the hypothetical FFD in the Colville River Delta Facility Group based on nesting densities reported for the Colville River Delta are presented in Table 4A.3.3-4.

TABLE 4A.3.3-4 ALTERNATIVE A – FFD SCENARIO – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Bird Group	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total[a]
Colville River Delta Facility Group					
Waterfowl	4	14	3	33	54
Loons	1	2	0	5	8
Ptarmigan	1	2	0	4	7
Raptors and Owls	0	0	0	0	0
Seabirds	1	2	0	4	7
Shorebirds	72	217	41	0	330
Passerines	35	107	20	0	162
Total Nests	**114**	**344**	**64**	**46**	**568**
Fish-Judy Creeks Facility Group					
Waterfowl	39	131	3	15	188
Loons	5	16	0	2	23
Ptarmigan	2	5	0	1	8
Raptors and Owls	0	0	0	0	0
Seabirds	8	28	1	3	40
Shorebirds	187	631	18	0	836
Passerines	123	415	12	0	550
Total Nests	**364**	**1,227**	**34**	**20**	**1,645**
Kalikpik-Kogru Rivers Facility Group					
Waterfowl	12	53	7	30	102
Loons	2	5	1	4	12
Ptarmigan	1	2	0	1	4
Raptors and Owls	0	0	0	0	0
Seabirds	3	11	2	6	22
Shorebird	59	253	36	0	348
Passerines	39	167	23	0	229
Total Nests	**115**	**492**	**69**	**41**	**717**

Notes:
[a] See Section 4A.3.3 for assumptions and calculation methods

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

In addition to habitat loss described under Alternative A – CPAI Development Plan for the ASDP, there would be additional habitat loss in the Colville River Delta for airstrips associated with the HP-7, HP-12, HP-13, and HP-14 sites. Gravel roads would connect HP-4, HP-5, and HP-8 to the Alpine Development Project.

Extensive nesting and brood-rearing surveys have been conducted in the Colville River Delta for loons and some waterfowl species (Johnson et al. 1999, Burgess et al. 2003a, Johnson et al. 2003a). Brood-rearing white-fronted geese have been reported in the vicinity of the HP-4, HP-5, HP-7, and HP-13 sites (Johnson et al.

2003b). A small brant colony and broods have been reported near the proposed HP-13 site, and the large Anachlik brant colony is near the HP-14 site (Johnson et al. 2003b). Fall-staging brant have been reported at the HP-7, HP-11, HP-13, and HP-14 sites (Johnson et al. 2003b). Tundra swan nests and broods are distributed throughout the Colville River Delta and have been reported in the vicinity of all the proposed FFD pads except HP-14 (Johnson et al. 2003b). These studies indicate that nesting yellow-billed loons could be affected by habitat loss and alteration at the HP-4, HP-5, HP-7, and HP-8 sites, and broods were reported near the HP-4 and HP-7 sites (Johnson et al. 2003b). Pacific loon nests and broods have also been reported in the general area of these proposed production pads as well as at the HP-13 site (Johnson et al. 2003b). During pre-nesting surveys, king eiders were recorded at numerous locations in the Colville River Delta including the proposed sites at HP-13 and HP-14, although king eiders were much more abundant in the transportation corridor between the Delta and the Kuparuk Oilfield (Johnson et al. 2003b).

Distribution information for gulls was available for four of the seven areas proposed for hypothetical FFD. Glaucous gulls used areas adjacent to HP-8, HP-4, HP-7 for nesting and brood-rearing, but did not use areas near HP-5 (Johnson et al. 2003b, Burgess et al. 2003a).

Ptarmigan, raptors and owls, seabirds, shorebirds, and passerines are expected to occur throughout the development area in numbers and distributions similar to the survey area covered for CPAI Development Plan alternatives in the Colville River Delta (Burgess et al. 2003a; Johnson et al. 2003a, 2003b). Densities for these species generated from intensive surveys were used to calculate the numbers of nests potentially affected by gravel placement. These bird groups use habitats in the Colville River Delta for brood-rearing, foraging, and migration staging.

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD in the Colville River Delta, aircraft traffic and noise would likely be a source of disturbance to birds, although disturbance related to vehicular traffic and machinery could also affect birds along the access roads to HP-4 and HP-5 and along the access roads from production pads to airstrips. The road from Nuiqsut could increase the potential for local traffic to affect birds along the access roads to the CD-2, CD-4, HP-4, HP-5, and HP-8 sites. The types of disturbances would be the same as those described above under Alternative A for the ASDP sites.

The density of nesting birds would be further reduced as a result of disturbance from the four additional airstrips in the lower Colville River Delta (Johnson et al. 2003a). Brood-rearing and staging waterfowl and loons in the lower Colville River Delta would also be disturbed and potentially displaced from the lower Delta by air traffic. Nesting and brood-rearing waterfowl occurring near the airstrips may need to be hazed from airstrips, increasing disturbance.

The few ptarmigan that nest in the lower Colville River Delta are not likely to be disturbed by the four additional airstrips. The few raptors and owls that nest in the Colville River Delta are not likely to be disturbed by the four additional airstrips in the lower Colville River Delta during nesting. A few foraging raptors may be disturbed or displaced by air traffic in the lower Colville River Delta when they concentrate to forage on staging shorebirds. Nesting, brood-rearing, and staging seabirds would be disturbed by the four additional airstrips in the lower Colville River Delta. The lower Colville River Delta is an important feeding area for post-breeding shorebirds. Foraging flocks of shorebirds would be disturbed and displaced from tidal habitats used in the lower Delta. An estimated 1,250 shorebirds would be potentially displaced by air traffic disturbance from 789 acres of Barrens, Tidal Flat, and Salt Marsh habitats within 500 meters of airstrips at HP-7, HP-12, HP-13 and HP-14. Nesting and foraging passerines would be disturbed by air and vehicle traffic and potentially displaced from adjacent habitats used in the Colville River Delta.

OBSTRUCTIONS TO MOVEMENTS

Under the FFD scenario for Alternative A in the Colville River Delta Facility Group, there would be little increase in the potential for the proposed development to obstruct bird movements. Most of the proposed sites are roadless, and there is little evidence that pipelines may present more than occasional, temporary obstruction to bird movements. Access roads would be constructed for the HP-4, HP-5, and HP-8 sites, and brood-rearing waterfowl and loons may have some difficulty crossing these roads, especially during the construction period. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to mitigate the potential for roads to obstruct bird movements.

MORTALITY

Mortality of waterfowl and loons, ptarmigan, seabirds, shorebirds, and passerines would result from collisions with vehicular traffic, buildings, pipelines, and bridges. Under Alternative A FFD, traffic levels in the Colville River Delta would be minimal because of the roadless condition of most of the project. However, mortality from collisions with aircraft would be increased for all bird groups by the four airstrips in the outer Colville River Delta. Seabirds, especially gulls, are particularly vulnerable to collisions with aircraft. Mortality-causing impacts from aircraft collisions could be mitigated by hazing of waterfowl and seabirds away from active airstrips.

Increased depredation from predators attracted to the proposed development could increase mortality of tundra-nesting adult birds, eggs, and chicks. In particular, seabirds, especially glaucous gulls, are likely to be attracted to the area. Road access from Nuiqsut may allow for increased subsistence hunting pressure on waterfowl and increased bird mortality near the CD-2, CD-4, and hypothetical HP-4, HP-5, and HP-8 sites. Alternatively, subsistence hunting could decrease in areas with oilfield developments if hunters avoid these areas.

FISH-JUDY CREEKS FACILITY GROUP

A summary of essential numbers of bird nests affected by the hypothetical FFD in the Fish-Judy Creeks Facility Group is presented in Table 4A.3.3-4.

HABITAT LOSS AND ALTERATION

Nesting, brood-rearing, and staging waterfowl and loons would be affected by habitat loss and alteration resulting from gravel placement. The following species have been recorded at hypothetical pad and production facilities in the Fish-Judy Creeks Facility Group (Burgess et al. 2003b, Noel et al. 2002c):

- HP-1: greater white-fronted goose, Canada goose, tundra swan, Pacific loon, yellow-billed loon
- HP-2: greater white-fronted goose, Canada goose, Pacific loon, yellow-billed loon
- HP-3: greater white-fronted goose, Canada goose, snow goose, brant, Pacific loon
- HP-6: Canada goose, brant, tundra swan, Pacific loon
- HP-15: greater white-fronted goose, brant, Pacific loon
- HP-16: tundra swan, Pacific loon, yellow-billed loon
- HP-17: tundra swan, Pacific loon
- HPF-1: greater white-fronted goose, tundra swan, yellow-billed loon.

Ptarmigan, raptors and owls, seabirds, shorebirds, and passerines are expected to occur throughout the development area in numbers and habitats similar to the survey area covered for the CPAI Development Plan alternatives in the National Petroleum Reserve-Alaska (Burgess et al. 2003b).

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD in the Fish-Judy Creeks Facility Group, vehicular traffic and other activities associated with the road system would be the greatest source of disturbance. In addition, noise associated with hypothetical processing facility HPF-1 could also affect birds. The mechanisms of impacts would be the same as those described above under Alternative A for the ASDP sites.

Traffic along the road that runs parallel to and crosses Judy Creek in two places would disturb female buff-breasted sandpipers that use stream corridors for migration, rest breaks during nesting, and brood rearing. Buff-breasted sandpipers were recorded on plots northeast of the proposed HPF-1 location (Burgess et al. 2003a). The proposed development would affect small amounts of habitats potentially used by this species.

OBSTRUCTIONS TO MOVEMENTS

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, potential obstruction to bird movements could occur along the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if the roads are open to local traffic. In general, roads do not present obstructions to bird movements. High traffic levels or high speeds on roads could pose some obstruction to bird movements if birds were displaced by disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to minimize potential for roads to obstruct bird movements.

MORTALITY

Other than mortality related to an oil spill, there would likely be little mortality related to the development under Alternative A FFD. Mortality of a few individual birds would result from collisions with vehicles. The potential for bird mortality associated with vehicular collisions under Alternative A FFD would be increased by the addition of 75 miles of road system. The level of mortality would probably be limited to a few individuals every year. Speed limits along roads, particularly during periods of poor visibility and during brood-rearing, may help to reduce the potential for collisions of birds with vehicles.

Some mortality to a few individuals or small flocks would result from collisions with structures such as elevated pipelines, communication towers, production modules, or bridges. The potential for bird mortality to result from collisions with structures under Alternative A FFD would be increased from CPAI Alternative A by the addition of 80 miles of pipelines.

Road access from Nuiqsut may increase the potential for subsistence hunting to affect birds along the entire road system for the Fish-Judy Creeks Facility Group. The potential for increased levels of depredation to affect tundra-bird nest success may increase under Alternative A FFD because of the increase in the amount of infrastructure. Studies at the Alpine Field have indicated that predators other than common ravens and glaucous gulls have not increased in response to the development (Johnson et al. 2003a). In recent years, oilfield operators have placed garbage that could attract predators into predator-proof dumpsters, and oilfield workers have been educated about the problems associated with feeding wildlife. Continuation of these practices in the FFD may help to minimize potential impacts to tundra-nesting birds.

There is evidence that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. Ongoing activities by researchers could cause some mortality to eggs and chicks of tundra-nesting birds. Increased aerial survey efforts from agency- and industry-sponsored studies to support development within the National Petroleum Reserve-Alaska may cause additional flushing and disturbance of pre-nesting waterfowl.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

A summary of the estimated number of bird nests affected by the hypothetical FFD in the area of the Kalikpik-Kogru Rivers Facility Group is presented in Table 4A.3.3-4.

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

Habitat loss and alteration could occur in addition to that identified for the CPAI Development Plan Alternative A in the Kalikpik-Kogru Rivers Facility Group as a result of gravel placement for four well pads, a processing facility, one airstrip, and 40 miles of gravel access roads (Table 4A.3.3-4). Waterfowl and loon concentrations are expected to be similar to those in other areas surveyed for waterfowl in the National Petroleum Reserve-Alaska (Johnson et al. 2003b, Noel et al. 2002c).

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD for the Kalikpik-Kogru Rivers Facility Group, vehicular traffic and other activities associated with the road system would be a source of disturbance to birds. Road access from Nuiqsut may increase the potential for local traffic to disturb birds along the entire road system of the Kalikpik-Kogru Rivers Facility Group. In addition, noise associated the hypothetical HPF-2 and air traffic at the HP-22 airstrip would disturb birds. The types of impacts would be the same as those described above for the CPAI Development Plan sites.

OBSTRUCTIONS TO MOVEMENTS

Under Alternative A FFD for in the Kalikpik-Kogru Rivers Facility Group, potential obstruction to bird movements would be increased by the addition of the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and would increase if the roads were open to local traffic. In general, roads do not present obstructions to bird movements. However, high traffic levels or high speeds on roads could pose some obstruction to bird movements. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, could help minimize the potential for roads to obstruct bird movements.

MORTALITY

The potential of the Alternative A FFD to affect mortality of tundra-nesting birds in the Kalikpik-Kogru Rivers Facility Group would be similar to that discussed above for the Fish-Judy Creeks Facility Group. The potential impacts might be less than those for the Fish and Judy creeks area because of the reduced amount of infrastructure in the Kalikpik-Kogru Rivers Facility Group. Road access from Nuiqsut may increase access and the potential for subsistence hunting to affect birds in the Kalikpik-Kogru Rivers Facility Group. Air strikes could cause additional mortality at the coastal airstrip at HP-22, particularly for waterfowl and seabirds.

There is evidence that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Götmark 1992). Birds that are flushed from their nests during surveys could be more susceptible to nest predation than undisturbed birds. Ongoing activities by researchers could cause some mortality to tundra-nesting bird eggs and chicks. Increased aerial survey efforts from agency- and industry-sponsored studies to support development within the National Petroleum Reserve-Alaska could cause additional flushing and disturbance of pre-nesting waterfowl.

4A.3.3.3 Alternative A – Summary of Impacts (CPAI and FFD) on Birds

Impacts to birds associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests effected by habitat loss, alteration or disturbance for each alternative, based on site specific nesting densities for bird species and species groups to compare alternative development scenarios.Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative A would reduce nesting by 2 % or less for Plan Area waterfowl, loon and seabird populations and less than 1 % for Plan Area shorebird and passerine populations. Alternative A – FFD Scenario would reduce nesting by 3 to 6 % for Plan Area waterfowl, loon and seabird populations and 1 % for Plan Area shorebird and passerine populations. Habitat loss does not involve the direct loss of active nests because winter gravel placement, iceroad construction, snow dumping, and snowdrifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The effects of these activities on estimated bird production due to loss, alteration or disturbance of nesting habitat for Alternative A, CPAI Development Plan and the FFD, are presented in Table 4A.3.3-5.

4A.3.3.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Birds

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

OBSTRUCTIONS TO MOVEMENTS

- Traffic speeds on roads would be reduced during brood-rearing.

MORTALITY

- Collisions with power lines could be minimized by marking lines with bird flight diverters.
- Waterfowl and seabirds would be hazed away from active airstrips to prevent collisions with aircraft.
- Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

TABLE 4A.3.3-5 ALTERNATIVE A (CPAI AND FFD) – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Bird Group	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total
CPAI Alternative A Totals[a]					
Waterfowl	9	40	7	21	77
Loons	1	5	1	3	10
Ptarmigan	1	2	1	0	3
Seabirds	1	8	2	2	13
Shorebirds	54	247	45	0	346
Passerines	33	146	27	0	206
Total Nests	**99**	**448**	**83**	**26**	**655**
FFD Scenario A Totals[a]					
Waterfowl	55	198	13	78	344
Loons	8	23	1	11	43
Ptarmigan	4	9	0	6	19
Seabirds	12	41	3	13	69
Shorebirds	318	1,101	95	0	1,514
Passerines	197	689	55	0	941
Total Nests	**593**	**2,063**	**167**	**107**	**2,930**

Notes:
[a] See Section 4A.3.3 Birds for assumptions and calculation methods. Totals from Tables 4A.3.3-2 and 4A.3.3-4.

4A.3.3.5 Alternative A –Effectiveness of Protective Measures for Birds

Stipulations 18 and 22 from the Northeast National Petroleum Reserve-Alaska IAP/EIS would help reduce disturbance of birds from ground transport and other activities; protect essential habitat by offsetting iceroad location annually; and restrict vehicle use to minimize vegetation-damaging and erosion-causing activities.

Aircraft disturbance of birds would be mitigated by maintenance of seasonal minimum flight altitudes (stipulation 56).

In addition to these stipulations, potential mitigation identified in this EIS would reduce disturbance and mortality associated with ground transportation by limiting traffic and reducing speeds, and reduce aircraft associated mortality by hazing birds away from active airstrips.

4A.3.4 Mammals

4A.3.4.1 Terrestrial Mammals

In this section we describe the potential impacts of Alternative A, considering general impact categories as in other recent impact assessments (TAPS Owners 2001, BLM 2002a, PAI 2002a). These categories include direct habitat loss, alteration, or enhancement; obstruction of movement; disturbance and displacement; and mortality. Impacts are addressed for the construction period, operation period, and FFD. It is important to recognize that several factors besides those directly associated with oilfield development and operations can affect the number and distribution of terrestrial mammals. These include habitat condition, population density, immigration/emigration, predation, hunting by humans, and other disturbances (Cronin et al. 1997, 1998b; BLM and MMS 1998a). In addition, population numbers and distribution and range condition may change, so impacts are potentially variable over time. Background information on terrestrial mammals in the Plan Area is presented in Section 3.3.4.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON TERRESTRIAL MAMMALS

Important characteristics of Alternative A with regard to effects on terrestrial mammals include the following. Alternative A would include 26 miles of road and 36 miles of pipeline (Figure 2.4.1.1-1). The pipelines in Alternative A have an adjacent road, except the route to the CD-3 in the Colville River Delta. There would be one new airstrip in Alternative A at CD-3. The total gravel fill (pads, roads, airstrips) for Alternative A would be 240 acres. In Alternative A, pipelines would be elevated to 5 feet, and industry and local residents would use the roads.

CONSTRUCTION PERIOD

Much of the construction of the CPAI Development Plan Alternative A would occur in winter, although considerable activity will occur year-round (Table 2.3.10-1). The primary terrestrial mammal species that could be affected during the construction period are caribou, muskoxen, moose, foxes, and grizzly bear. Caribou, fox, and grizzly bears may be in the Plan Area year-round, although moose and muskoxen are uncommon in the Plan Area in winter. In winter, grizzly bears will be in dens and could be affected by noise from ice road and gravel road construction, Rolligon traffic, and pipeline installation within a mile of a den. Improperly stored garbage and direct feeding by people can cause food conditioning in foxes and potentially locally increase fox populations, although regulations prohibit such feeding.

Direct Habitat Loss, Alteration, or Enhancement

The construction phase of the ASDP is scheduled to occur between 2005 and 2010. Ice roads used for construction of roads, pads, and airstrips, and the areas covered with gravel, would comprise the areas of lost wildlife winter forage. Gravel fill has an impact on wildlife habitats in the Arctic because the loss of vegetation is long-term and revegetation of gravel sites may be difficult (PAI 2002a). Areas covered with gravel are effectively removed as foraging habitats for terrestrial mammals unless vegetation is restored. However, gravel fill may create insect relief habitat for caribou (Pollard et al. 1996a, 1996b) and possibly other species (such as muskoxen and moose).

Alternative A would result in construction of gravel roads from CD-1 to CD-4, and from CD-2 to CD-5, CD-6, and CD-7. Table 4A.3.4-1 lists the surface area that would be covered by gravel fill for pads, roads, and airstrips for the six action alternatives, and Table 4A.3.4-2 lists the miles of roads and pipelines for each of the six action alternatives. Table 4.A.3.1-2 lists total surface areas for each type of habitat in the Plan Area that would be replaced by gravel fill for the six alternatives. Road gravel would already be in place for production pad construction of CD-5. No road is planned to CD-3, so the pipeline would be constructed with access by ice road (about 35 feet wide).

TABLE 4A.3.4-1 APPROXIMATE ACRES OF GRAVEL FILL FOR PADS, ROADS, AIRSTRIPS, AND TOTAL FOR THE SIX ALTERNATIVES

Alternative	Pads and Airstrips	Roads	Total
A	67	174	241
B	135	69	204
C-1	47	276	323
C-2	49	275	324
D-1	221	0	221
D-2	71	0	71
F	69	182	251

TABLE 4A.3.4-2 MILES OF ROADS AND PIPELINES FOR THE SIX ALTERNATIVES

Alternative	Roads with Pipeline	Total Pipelines	Pipeline Without Road
A	26	36	10
B	10	36	26
C-1	42	42	0
C-2	37	41	4
D-1	0	33	33
D-2	0	33	33
F	28	37	9

The placement of gravel fill in Alternative A would reduce summer and winter forage available for caribou, moose, and muskoxen. It is not known if the numbers of these species on the North Slope are limited by forage in any season. However, the loss of forage habitat is a small part of the Plan Area, so this impact would be small in magnitude during the construction period. This could change as populations fluctuate and range conditions change. See the Operation Period subsection below for quantification of habitat types lost or altered beneath gravel fill.

Grizzly bears could lose some foraging habitat and den habitat beneath the gravel fill placed under Alternative A. Because bears on the North Slope generally use a den only once (Shideler 2000) avoiding old dens during construction would not necessarily mitigate impacts. In general, the entire Colville River Delta and well-drained areas west of the Colville River are considered potential den habitat for grizzly bears without specific high-concentration areas identified. The ADF&G has recently expanded surveys to include the Northeast National Petroleum Reserve-Alaska, and identified a number of dens used by both marked and unmarked bears in areas along Fish and Judy creeks and the Kalikpik River. This indicates these areas may be used considerably as den habitat. (Shideler, pers. comm. 2003). Potential loss of grizzly bear den habitat under Alternative A is discussed in the Operation Period subsection below.

There are few data on site-specific den densities in the Northeast National Petroleum Reserve-Alaska, but aerial surveys within the Fish-Judy Creeks Facility Group found five bear dens within a 425-mi^2 (1,100-km^2) area (Burgess et al. 2003b). All dens were within 2 miles of riparian areas. Three dens were near Fish Creek, and one den was near the Ublutuoch River. The dens were at least 3 miles apart. Good den habitat is probably scattered throughout the Plan Area, particularly in upland areas and river banks, and some dens could be affected by development. Most bears initially collared in the Kuparuk area, but re-collared in the National Petroleum Reserve-Alaska, were found in the Ocean Point area. Results from recent surveys by the ADF&G indicate that bears occur throughout the Plan Area, particularly in riparian areas (Shideler, pers. comm.). However, there are no data to suggest that the number or distribution of bears is limited by den habitat within the Plan Area, so impacts to the population during the construction period would probably be small in magnitude.

Fox dens also may be affected by construction activities, although they vary in activity annually and may not be relevant to long-term predictions. Within the Colville River Delta Facility Group in Alternative A, the road from CD-1 to CD-4 could be close to one inactive (summer 2002) red fox den (Johnson et al. 2003a). Within the vicinity of the Fish-Judy Creeks Facility Group, the pipeline/road complexes may be close to or may cover one inactive arctic fox den between CD-2 and CD-5, one inactive and two active arctic fox dens between CD-5 and CD-6, and three inactive and one active arctic fox den between CD-6 and CD-7. Sites suitable as potential denning habitat would likely be covered by gravel, but den site availability on the North Slope probably does not limit fox populations (Burgess 2000). Red foxes and arctic foxes have made dens in culverts and other oilfield structures on the North Slope (Burgess et al. 2002b) so a small amount of artificial habitat suitable for use as den sites may be created. Arctic foxes generally do not avoid human activity where they are not harassed or hunted. Arctic foxes may be particularly attracted to human activity or developed sites in winter when food is scarce or they are seeking shelter (NRC 2003). Aggregations of foxes have been found in winter at garbage dumps on the North Slope and adjacent to other developed areas in the past (Burgess 2000). However, proper implementation of plans to prevent feeding wildlife in the Plan Area as outlined by the BLM and MMS (1998b) and state regulation can prevent foxes (and bears) from becoming habituated to human food.

Wolves, wolverines, and red foxes are uncommon in the Plan Area (Burgess et al. 2003b, Johnson et al. 1999) and the loss of habitat from construction activity would be limited (BLM and MMS 2003). Red foxes den annually in the ASDP Area, with approximately two or three dens per year on the Delta and probably a similar number in the National Petroleum Reserve-Alaska. Some small-mammal habitat would be lost beneath gravel fill and ice roads. For example, arctic ground squirrels occur in areas with well-drained, stable soils. However, the amount of habitat lost will be small compared to that available in the Plan Area.

Obstruction of Movements

Construction and use of ice roads, gravel roads, and other infrastructure will occur during the summer and winter for several years. The structures themselves, and human activity, may obstruct the movement of animals in the Plan Area. The mammals in the area may be particularly sensitive to human activity and novel infrastructure because they have not been exposed to it before as have the animals in the areas with existing oil fields to the east of the Plan Area. This may be particularly relevant for caribou of the TCH in the early years of the project because they have not been exposed to oilfields previously and they have been hunted regularly.

Obstruction of movements during the construction phase may be more pronounced than during the operation period because of the relatively high level of traffic and other activity (Table 2.3.10-1) (Pullman and Lawhead 2002). For example, in northeastern Alberta, roads obstructed caribou movements the most in late winter (Dyer et al. 2002). However, winter movements have not been significantly obstructed by the TAPS (TAPS Owners 2001a). In winter, caribou may seek areas with soft snow or windblown areas where snow tends to be shallow (Miller et al. 1982, Russell et al. 1993). Therefore, potential for obstruction of movements would be greatest if snow is deep during construction. Vehicle traffic on ice roads may be greater than 6,000 vehicles per month during the construction phase of Alternative A (Table 2.3.10-1), which could obstruct caribou movements to some extent. Use of the project roads for hunting access could obstruct caribou and other mammals' movements by deflecting animals away from roads from which hunting occurs.

Most of the CAH winters south and east of the Plan Area, and most of the TCH winters to the west and southwest of the Plan Area (PAI 2002a). However, considerable numbers of TCH caribou use winter ranges in the Plan Area (Figure 3.3.4.1-5) (Prichard et al. 2001; Burgess et al. 2002b, 2003b; BLM and MMS 2003), and some obstruction of movements could occur between CD-2 and CD-7 during construction of the road and pipeline. Ice roads, vehicle traffic, and construction activities may also affect the movements of muskoxen and moose during construction, although few of these species are likely to occur in the Plan Area in winter.

Construction during winter would not obstruct movements of grizzly bears that are in dens at that time. Arctic foxes are generally tolerant of human activities and may roam widely throughout the winter, depending on food supplies (Burgess 2000). Construction activities during this time are not expected to affect their movements. Foxes could be attracted to construction activities out of curiosity, even if food is not available.

Construction activities and noise may temporarily alter the distribution and movements of wolves, wolverine, and red foxes in the Plan Area. Wolves avoided highly-traveled roads in the Kenai National Wildlife Refuge but used closed or lightly traveled roads as travel corridors (Thurber et al. 1994). These species are not common in the Plan Area in the winter and impacts on them will be limited.

Disturbance and Displacement

In general, disturbance can be considered impacts that change behavior or cause stress in animals. Displacement refers to movement from one area to another in response to disturbance. It is important to note that disturbance and displacement can vary in intensity and over time. The construction activity for Alternative A will result in some disturbance to the terrestrial mammals in the Plan Area. If disturbance results in displacement from preferred habitats, or significant energy costs, it can have negative impacts on animals' condition, reproduction, or survival. If there is adequate alternative habitat and minor energy costs, disturbance and displacement may not negatively impact animals. Construction activity and new infrastructure may temporarily affect caribou distribution (Mahoney and Schaeffer 2002). Maternal caribou are more sensitive to disturbance than those without calves, especially during the calving period (de Vos 1960, Bergerud 1974, Roby 1978, Haskell 2003). For example, some caribou cows with calves avoided the trans-Alaska pipeline corridor and oilfield roads during construction (Cameron et al. 1979; Dau and Cameron 1986b; Johnson and Lawhead 1989; Lawhead et al. 2003). Construction activities of the Alternative A facilities in winter would avoid both the caribou calving period, and the summer when the largest number of caribou typically occur in the Colville Delta portion of the Plan Area (PAI 2002a). However, traffic levels will be much higher in the construction period than the subsequent operational period and some construction will occur year-round (Table 2.3.10-1). Densities of over-wintering TCH caribou in the vicinity of Judy and Fish creeks ranged from 0.3 to 0.75 caribou/km^2. Densities between May and October were 0.75 to 2.1 caribou/km^2 (Burgess et al. 2002b, 2003b). The areas south of the road to CD-7, near the Ublutuoch River, and in the vicinity of the Kalikpik and Kogru rivers have supported the highest densities of overwintering caribou in the Plan Area (BLM and MMS 2003, Figure 7). The Clover Potential Gravel Source, near the Ublutuoch River, might also support a high density of overwintering caribou. The potential disturbance associated with construction could cause the caribou in the vicinity to move more frequently and expend more energy (Smith et al. 2000). Caribou are relatively sedentary and less sensitive to disturbance during winter than during calving and summer periods, so these impacts would be limited (Skoog 1968, Dauphine 1976, Roby 1978). However, disturbance in the winter could still affect the animals negatively if it results in large energy loss or displacement to poor habitat.

There will be a considerable level of traffic during the summer construction periods also. This may result in disturbance and displacement of caribou and the other mammal species in the Plan Area. Disturbance would be localized around construction sites and the road and pipeline corridors associated with CD-3 and CD-4 in the Colville River Delta and CD-5, CD-6, and CD-7 in the vicinity of Fish and Judy creeks. If there is hunting in the area, caribou may be more sensitive to human activities than in unhunted areas and may avoid all human activity, including construction areas.

Moose and muskoxen are likely to occur in small numbers in the Plan Area during winter, and more frequently in the summer. Therefore, some disturbance may result from construction activities, especially in riparian areas. Few muskoxen occur west of the Colville River (Lenart 1999a), and the BLM and MMS (2003) identified the best potential habitat for muskoxen as south of the Plan Area. There is potential muskoxen habitat in the Plan Area. Studies on the North Slope show that undisturbed muskoxen tend to form larger groups and remain in a relatively small area in winter (27 to 70 km^2) than in summer (USGS 2002, Lenart 1999a). Female muskoxen drop calves in April and May before new vegetation emerges, and movement rates of satellite-collared animals were lowest at that time (Reynolds et al. 2002). The areas used in summer are significantly larger (223 km^2) than in winter or during the calving period (USGS 2002). Moose use riparian areas, especially those of the Colville River upstream of the Plan Area, and numbers in the Plan Area are generally small (Figure 3.3.4.1-10) (PAI 2002a). The relatively small numbers of muskoxen and moose and ample available habitat adjacent to the Alternative A infrastructure in the Plan Area suggest that disturbance and resulting displacement during construction would have limited impacts on these species.

Grizzly bears on the North Slope hibernate in dens beginning in late September and early November. They emerge between March and May. Bears in dens may be disturbed by the noise and activity during the winter construction associated with Alternative A (Reynolds et al. 1976, Shideler and Hechtel 2000). Grizzly bears hibernating in dens within a few miles of construction may be disturbed by noise from ice and gravel road construction, installation of pipelines, Rolligon traffic, and drilling operations (BLM and MMS 2003). Bears hibernating within 600 feet of construction activities may abandon their dens, which would result in negative impacts on those individuals, especially of newborn cubs (Reynolds et al. 1986, BLM and MMS 2003). Mortality could result if bears do not re-enter dens, and experience exposure and nutritional stress. Spatial and temporal restrictions on development activities could prevent abandonment of dens (Amstrup 1993). For example, stipulations to avoid known dens by 0.5 mile would mitigate this impact for some bears. Implementation of the 0.5mile avoidance stipulation and denning habitat away from the development area would minimize impacts on grizzly bears during construction. However, if bears enter dens and are undetected prior to construction activity, they will be susceptible to disturbance from construction noise. Small-mammal densities are unknown but are probably variable over years and by habitat type. The effects of disturbance on these species would be limited to the areas covered by ice roads and gravel deposition.

The winter distribution of arctic foxes is heavily influenced by food availability (Burgess 2000). Arctic foxes can habituate to human activity, so the effects of disturbance on foxes from winter construction would probably be small. However, if foxes are hunted or trapped, they might avoid human activity including construction areas. Similarly, noise and traffic from construction could displace wolves and wolverines from construction areas. However, few wolves and wolverines occur in the Plan Area, so impacts would be limited.

Mortality

Potential sources of mortality may include vehicle collisions, poisoning (e.g., ingestion of industrial materials), disease (such as rabies in foxes), nuisance or defense-of-life-and-property (DLP) kills, and enhanced predation or increased hunting. Accidental road kills of caribou, bears, and other mammals in the existing North Slope oilfields are uncommon (Murphy and Lawhead 2000; TAPS Owners 2001a; C. Rea, CPAI 2004, pers. comm.). During the winter construction period, grizzly bears would be in dens, and wolves, muskoxen, and moose are relatively uncommon in the Plan Area, so direct mortality of these species would likely be limited in winter. Caribou occur in the Plan Area in winter, and road kills are possible, especially with the high levels of traffic during construction (Table 2.3.10-1) and the dark driving conditions of winter. Foxes and other small mammals are also vulnerable to vehicle collisions, particularly in the winter because of the high traffic level and darkness. However, in the Kuparuk Oilfield between 1987 and 2003 there was only one fox-vehicle collision mortality reported (C. Rea, CPAI 2004, pers. comm.). Wildlife in the Plan Area has been exposed to hunting, so they may avoid human activity, which would reduce the chance of vehicle collisions, DLP mortality, or exposure to poisons. If any bears are displaced from denning locations they could either die from exposure, lack of nutrition, or they could be killed in DLP.

OPERATION PERIOD

The same general impacts described in other oilfield operations are relevant to this project (BLM and MMS 1998a, 2003; TAPS Owners 2001a; Truett and Johnson 2000; BLM 2002a). In this section on the Operation Period under CPAI Development Plan Alternative A, we briefly review the literature dealing with the impacts of oilfield operations on terrestrial mammals. This background material will apply to all Alternatives.

Direct Habitat Loss, Alteration, or Enhancement

The extent of habitat directly lost under Alternative A would be that covered by gravel fill and tundra excavated to obtain that gravel. This would include 240 acres of vegetation under gravel roads, pads, and the airstrip at CD-3, and approximately 65 acres of vegetation cover could be lost at Clover. The primary habitat value lost would be forage for caribou, muskoxen, moose, and grizzly bear. As described below, the loss of forage for caribou, muskoxen, moose, and grizzly bear under gravel fill would be a small proportion of that available in the Plan Area. The amount of forage lost would probably be inconsequential to the animals using the Plan Area because alternative habitat would be available. Some natural denning habitat for grizzly bears and foxes could be lost. Anthropogenic (resulting from human activity) denning habitats for foxes could be created which could enhance fox reproduction or conversely, increase the probability of vehicle collisions or food conditioning and subsequent mortality.

Caribou, muskoxen, moose, and grizzly bears use a variety of habitat types on the Coastal Plain. Potential loss of preferred caribou habitat types resulting from gravel placement under Alternative A are quantified below. During calving, caribou use moist tundra and feed on *Eriophorum vaginatum* (tussock cottongrass). Their diet broadens during the summer after calving and include *Eriophorum vaginatum* (tussock cottongrass), *E. angustifolium* (tall cottongrass), *Carex aquatilis* (aquatic sedge), and *Salix planifolia* ssp. *pulchra* (diamond-leaf willow) (Murphy and Lawhead 2000; PAI 2002a; Jorgenson et al. 2003c, and references therein). These species occur in the two most important habitat types used by caribou during summer: Moist Sedge-Shrub Meadow and Moist Tussock Tundra (Section 3.3.4.1) (Lawhead et al. 2003, Russell et al. 1993, Jorgenson et al. 2003c). The Barrens habitat type also provides insect-relief to caribou in summer (Jorgenson et al. 2003c), and a small amount of this habitat would be lost under gravel fill. However, insect relief habitats would also be created on gravel roads, pads, and in areas shaded by pipelines and structures. Some TCH and CAH caribou overwinter on the coastal plain (Davis and Valkenburg 1978, Prichard et al. 2001, PAI 2002a), and the TCH animals may use habitats in the Plan Area. The fall and winter diets of caribou are dominated by lichens, which comprise 65 % of the winter diet of PCH caribou (Thompson and McCourt 1981, Russell et al. 1993, Murphy and Lawhead 2000). Caribou of the WAH also use mostly lichen (69 %) in addition to graminoids (19 %) during winter (Jandt et al. 2003). Muskoxen use a variety of habitats, depending upon the season. Sedges found in Moist Tussock Tundra and Moist Sedge-Shrub Meadow habitats are important forage plants for muskoxen in spring (Jingfors 1980, Reynolds et al. 1986, PAI 2002a). Willow, forbs (including legumes), and sedges (Robus 1984, O’Brien 1988, PAI 2002a) are important forage plants for muskoxen in late spring and summer. These plants occur in river terraces, gravel bars and shrub stands along rivers and tundra streams (Jingfors 1980, Robus 1981, PAI 2002a). Muskoxen select upland habitats that allow access to food plants, such as places with shallow, soft snow cover in upland habitats near ridges and bluffs (Klein et al. 1993, PAI 2002a). The most important habitat types for muskoxen on the Colville River Delta include the Riverine, Upland Shrub, and Moist Sedge-Shrub Meadow habitat types (PAI 2002a; BLM and MMS, 2003, and references therein). Potential losses of preferred muskoxen habitat types resulting from gravel placement under Alternative A are quantified below.

Moose range from the northern foothills of the Brooks Range to the Arctic Coast in the summer and move to riparian corridors of large river systems in fall. They concentrate in those riparian areas in winter. The largest winter concentrations are in the inland reaches of the Colville River (Carroll 2000b). In spring, moose generally remain in riparian areas, but also move to other areas. The tall shrubs, including willow and alder shrub thickets, are important browsing species for moose, particularly in winter (Mould 1979, PAI 2002a, BLM and MMS 2003). These plants occur in Riverine and Upland Shrub habitat types on the coastal plain, so these habitat types are important to moose. Potential losses of these preferred moose habitat types resulting from gravel placement under Alternative A are quantified below.

Hedysarum alpinum (peavine roots) and various legumes (found in river terraces and bars) are important food sources for grizzly bears in the early spring. *Equisetum arvense* (field horsetail) and various grasses and sedges are important forage plants in summer, and *Arctostaphylos rubra* (bearberry) is important in late summer and early fall (Shideler and Hechtel 2000). These plant species occur in the Riverine, Upland Shrub, and Moist Sedge-Shrub Meadow habitat types and sometimes in the Barrens habitat type, all of which are important for grizzly bears (Shideler and Hechtel 2000; Jorgenson et al. 2003c; PAI 2002a, and references therein). The Riverine and Upland Shrub habitat types are used by grizzly bears for foraging and denning areas, travel corridors, and access to prey species (such as ground squirrels) (Johnson et al. 1996, Shideler and Hechtel 2000). Other sites used by grizzly bears during the summer include ground squirrel mounds, meadows below snowbanks, and the ecotone between wet sedge and drier habitats (Shideler and Hechtel 2000). In addition to streambanks and hillsides, grizzly bears commonly den in pingos (Shideler and Hechtel 2000). Sand dunes and other well-drained areas that are more common in the Plan Area than areas to the east with existing oil field development could provide more of these habitats for bears. Potential losses of these preferred grizzly bear habitat types resulting from gravel placement under Alternative A are quantified below.

A total of 2,927 acres of Moist Sedge-Shrub Meadow are available in the Colville River Delta (Table 4A.3.3-3). A habitat map is available for 175,152 acres in the National Petroleum Reserve-Alaska, but not for the entire area (Figure 3.3.1.3-1). The total area of Moist Sedge-Shrub Meadow in the habitat-typed area of the National Petroleum Reserve-Alaska is 42,071 acres (Table 4A.3.3-3). A total of 43.2 acres (9.0 acres in the Colville River Delta, 34.2 acres in the National Petroleum Reserve-Alaska) of Moist Sedge-Shrub Meadow would be lost as a result of gravel placement (roads, pads and airstrips) under Alternative A (Table 4A.3.1-2). The potential loss of Moist Sedge-Shrub Meadow from gravel fill is less than 0.2 % of that available on the Colville River Delta. The proportional loss of habitat in the National Petroleum Reserve-Alaska cannot be calculated because a habitat map is not available for the entire area. However, in the part of the area for which habitat typing is available, the potential loss of Moist Sedge-Shrub Meadow habitat type resulting from gravel fill in the area in the National Petroleum Reserve-Alaska is less than 0.1 % of that available. In addition to that habitat affected by gravel fill, 258.7 acres (60.8 acres in the Colville River Delta; 197.9 acres in the National Petroleum Reserve-Alaska) of Moist Sedge-Shrub Meadow would be altered by dust and alteration of thermal and moisture regimes (as calculated for vegetation impacts in Section 4A.3.1).

The combined area of riverine and upland shrub habitats in the Colville River Delta is 7,994 acres (Table 4A.3.3-3). The combined area of riverine and upland shrub habitats in the habitat-typed area in National Petroleum Reserve-Alaska is 4,778 acres. A total of 8.3 acres (8.0 acres in the Colville River Delta, 0.3 acre in the National Petroleum Reserve-Alaska) of riverine and upland shrub habitats would be lost as the result of gravel placement (roads, pads, and airstrips) under Alternative A. The potential loss under gravel fill in the Colville River Delta and the habitat-typed area in the National Petroleum Reserve-Alaska is less than 0.1 % of the riverine and upland shrub habitats available in that area. In addition to gravel fill, 27.7 acres (26.1 acres in the Colville River Delta; 1.6 acres in the National Petroleum Reserve-Alaska) of riverine and upland shrub habitats would be altered by gravel fill related impacts.

A total of 525 acres of Moist Tussock Tundra habitat type is available in the Colville River Delta. The total area of Moist Tussock Tundra in the habitat-typed area of the National Petroleum Reserve-Alaska is 49,647 acres (Jorgenson et al. 2003c). A total of 96.5 acres (1.1 acres in the Colville River Delta, 95.4 acres in the National Petroleum Reserve-Alaska) of Moist Tussock Tundra would be lost or altered under Alternative A. The potential loss from gravel fill in the habitat-typed area in the Colville River Delta and the National Petroleum Reserve-Alaska is less than 0.1 % of the Moist Tussock Tundra habitat type available in that area. In addition, no acreage would be altered in the Colville River Delta, and 486.0 acres of the Moist Tussock Tundra habitat type would be indirectly altered in the National Petroleum Reserve-Alaska.

The total area of Barrens habitat type in the Colville River Delta is 20,993 acres (Table 4A.3.3-3). The total area of Barrens in the habitat-typed area of the National Petroleum Reserve-Alaska is 1,552 acres. A total of 1.3 acres of Barrens would be lost as the result of gravel placement (roads, pads, and airstrips) in the Colville River Delta, and no Barrens would be lost or altered in the National Petroleum Reserve-Alaska under Alternative A. The potential loss of Barrens habitat is less than 0.1 % of that available in the Colville River Delta. In addition to Barrens habitat lost as the result of gravel fill in the Colville River Delta, 16.1 acres of Barrens habitat type would be indirectly altered under Alternative A, while no acreage would be altered in the National Petroleum Reserve-Alaska.

In the Prudhoe Bay Oilfield and adjacent oilfields, caribou sometimes occur on gravel pads and roads in the summer. The abundance of mosquitoes and oestrid flies on gravel pads is lower than adjacent tundra so gravel structures may provide insect-relief habitat (Pollard et al. 1996a). This is most common during periods of harassment by oestrid flies, but it is possible that caribou also use gravel structures during harassment by mosquitoes (Pollard et al. 1996b, Noel et al. 1998, Ballard et al. 2000, Murphy and Lawhead 2000). Such use of the roads and pads developed under Alternative A could increase potential insect relief habitat in the summer. However, the small amount of such habitat created and the potential for human disturbance to reduce the attractiveness of the gravel structures to caribou suggest this would not likely provide a measurable benefit at the population level. Other habitat alterations that could benefit caribou could also occur. Caribou could be attracted to areas of dust fallout where there is early snowmelt and plant emergence near roads in spring (Roby 1978, Lawhead and Cameron 1988, Smith et al. 1994). Other areas near infrastructure where impounded water or accumulated snow causes delayed plant phenology and senescence could also enhance habitat for caribou (Roby 1978). Also, caribou might use patches of persisting snow next to pipelines for relief from heat in June. However, there could be an increased risk of vehicle collisions if caribou use habitats close to roads and structures.

Oilfield operations in the Prudhoe Bay area appear to have increased the availability of food, shelter, and possibly numbers of grizzly bears and arctic foxes (Shideler and Hechtel 2000, Burgess 2000). However, many of the bears raised as food-conditioned bears have been killed in recent years by hunters or in DLP incidents (Shideler and Hechtel 2000). The density of arctic fox dens and offspring productivity was higher in the Prudhoe Bay Oilfield than in undeveloped areas to the east (Eberhardt et al. 1983, Burgess et al. 1993, Ballard et al. 2000). Foxes are attracted to garbage dumpsters as a source of food and may also den or seek shelter beneath buildings, in culverts, or in other structures (Burgess 2000).

Disturbance and Displacement

During the operation period of Alternative A, terrestrial mammals may be disturbed and displaced by vehicular traffic, low-flying aircraft, unfamiliar infrastructure, noise and activity on facilities, road and pipeline maintenance, and humans on foot (Shideler 1986). Vehicle and aircraft traffic will be considerably lower during the operation period than during the construction period (Table 2.3.10-1) so disturbance will decrease over time. Humans on foot tend to elicit the most regular flight responses of caribou (Roby 1978, Murphy and Lawhead 2000). Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality to animals can result from surveys and capture activities (Bart 1977, Götmark 1992). Designing research to minimize disturbance and mortality can mitigate this potential impact.

Oilfield operations in the Plan Area could disturb and displace caribou from preferred habitats. This could include vehicle and air traffic, and general human activity. This would not be common for calving caribou because the Alternative A proposed facilities are not near the primary calving areas of the CAH or TCH caribou. Disturbance could displace caribou to areas of poor insect-relief value in summer or poor forage availability in any season. However, the amount of habitat directly lost to infrastructure under Alternative A is a small proportion of that available in the Plan Area, so it is probable that there is adequate habitat away from the proposed infrastructure. Disturbance and displacement of caribou of the CAH in the Prudhoe Bay, Kuparuk, and Milne Point oilfields have been studied extensively. Cow caribou with calves tend to be most sensitive to disturbance during the calving period in late May until approximately 20 June. In this period, displacement of 1 km away from roads with traffic (Dau and Cameron 1986; Cameron et al. 1992b; Lawhead et al. 2002, 2003) and a general shift away from development have been reported (NRC 2003, USGS 2002, Murphy and Lawhead 2000, Lawhead et al. 2003). Others have also reported that caribou cows with calves generally avoid areas of human activities by up to 1 km and are sensitive to human-caused disturbance (Johnson and Lawhead 1989, de Vos 1960, Lent 1966, Bergerud 1974). However, studies in the Milne Point Oilfield from 1991 to 2001 suggest displacement from roads may not occur during the calving period (Haskell 2003, Noel et al. 2004). With regard to regional calving shifts, factors other than the oilfields may be responsible (Murphy and Lawhead 2000). Factors such as timing of snowmelt, range conditions, presence of predators, and animal population density could also result in shifting of calving areas.

Avoidance of the oilfields by caribou during the post-calving summer period has also been reported (Cameron et al. 1995, 2002; NRC 2003). However, caribou use habitats in the Prudhoe Bay Oilfield frequently and are not displaced from infrastructure in the post-calving period (Pollard et al. 1996b; Noel et al. 1998; Cronin et al. 1998a, 1998b). During the post-calving period, CAH caribou of all sex and age classes frequently forage adjacent to, and rest on, gravel roads and pads or in the shade of oilfield buildings and pipelines (Lawhead et al. 1993; Pollard et al. 1996b; Cronin et al. 1998a, 1998b; Noel et al. 1998; Ballard et al. 2000; Haskell, 2003).

Recent impact assessments have led to the hypothesis that displacement from oilfield infrastructure during the calving period may affect the nutritional status of cow caribou and result in reduced calf production and reduced herd growth. In particular, comparison of caribou in contact with oilfields (west of the Sagavanirktok River) and not in contact with oilfields (east of the Sagavanirktok River) have suggested such effects (Cameron et al. 2002, Griffith et al. 2002, NRC 2003). However, the CAH has grown from approximately 5,000 to 32,000 animals since the beginning of oilfield development (Cronin et al. 1998b; Arther and Del Vecchio 2003; NRC 2003). The numbers of animals in the western part of the calving range with oilfields has increased along with the entire herd, and the calf/cow ratios in the oilfield areas have been as high or higher than in undeveloped areas (Maki 1992; Cronin et al. 1998b, 2000, 2001). Factors such as population density, range condition, and movements of animals, in addition to calf recruitment, are probably responsible for the changes in numbers of animals in the areas east and west of the Sagavanirktok River (Cronin et al. 1997, 2000). Other herds without oil fields in their ranges have shown varying trends in population growth over the same time period. The TCH and the WAH in northern Alaska have exhibited faster population growth than the CAH during the same time frame, but the PCH grew during the 1970s and 1980s and declined in numbers since 1990 (Cronin et al. 1998b, NRC 2003).

Other studies of disturbance of caribou in oilfields provide additional insights. Roby (1978) found that caribou changed behavior within 656 to 984 feet of the Dalton Highway depending on sex, age, and time of year. Lawhead and Murphy (1988) and Lawhead (1990) reported that under varying levels of insect harassment and road traffic about 83 % of acute disturbance events occurred within 328 feet of the Endicott Road in the North Slope oilfields. Haskell (2003) reported that 90 % of the behavioral reactions to humans occurred within 1,640 feet of the observer's vehicle. Murphy and Curatolo (1987) determined that moving stimuli such as vehicles were more disruptive to caribou behavior than stationary infrastructure such as pipelines and roads. It is important to note that disturbance reactions may vary and caribou might habituate to human activity, including oilfields (Bergerud et al. 1984, Cronin et al. 1994). Shideler (2000) noted that CAH caribou habituated to development over several years. Haskell (2003) reported that rehabituation of CAH caribou occurred annually and the timing and extent of habituation was positively correlated with the timing of spring snowmelt.

Considering the varying responses of caribou to oilfields, it is not possible to explicitly predict the impacts of the proposed action. However, it is reasonable to expect that the activities associated with Alternative A may cause some displacement and disturbance of caribou in the Plan Area. Such impacts have been the greatest during the calving period in the existing oilfields (USGS 2002, NRC 2003). Because little calving occurs in the areas to be developed in Alternative A (Figure 3.3.4.1-2), few impacts during the calving period are expected. Caribou could be disturbed and displaced during the post-calving period and winter when more caribou are present. Vehicle traffic on the roads between CD-1 and CD-4 and between CD-2 and CD-7, as well as activity on the facility pads and the airstrips, could disturb caribou. The pipeline without a road between CD-1 and CD-3 would not disturb caribou after construction, but aircraft operations between these sites could. Aircraft supporting operations of Alternative A can be expected to add disturbance, particularly near the airstrip at CD-3 when flights are at low altitude. It has been noted that in some cases disturbance from aircraft may be greater than that from road traffic (BLM 2004a). However, there would be less aircraft traffic, but greater road access, under Alternative A than Alternatives B and D.

Lack of previous exposure of the TCH caribou to oilfields may result in more disturbance and displacement than that of the CAH caribou in the existing oilfields. This sensitivity may lessen with time as the TCH caribou habituate to the oilfield activity and infrastructure (Cronin et al. 1994, Haskell 2003). Caribou from the CAH also use the Plan Area and may already be habituated to oilfield activity. Conversely, use of the Alternative A project roads by local residents in addition to industry may result in higher levels of traffic and increased disturbance. This may be particularly important if the local residents are hunting and cause caribou and the other terrestrial mammals in the Plan Area to avoid human activity. Caribou in the Plan Area may habituate to the oilfield structures, but not snowmobiles and trucks if they are associated with hunting.

Grizzly bears frequently avoid roads and human activity and flee in reaction to humans on foot (Harding and Nagy 1980). However, they may become habituated to noise and human activity over time, which would increase the likelihood of human-bear interactions (McLellan and Shackleton 1989, Shideler and Hechtel 2000). Grizzly bears often run or hide in response to aircraft (McLellan and Shackleton 1989, BLM and MMS 2003). Responses vary among individual bears depending on availability of cover, habituation, and aircraft flight characteristics (Harting 1987). Capturing associated with biological research may sensitize bears to disturbance from helicopters.

The existing North Slope oilfields have increased the number of human-bear interactions (NRC 2003). Bears have been conditioned to use human foods because of poor garbage management in Deadhorse and Prudhoe Bay. These bears may be attracted to human activity and killed by hunters or because of safety concerns (Shideler and Hechtel 2000). During the 1980s and early 1990s, six adult female and two adult male bears in the oil field region fed on garbage. These females that were conditioned to eating anthropogenic food had cubs with higher survival to weaning (77 %) than did females eating only natural foods (47 %). However, food-conditioned subadults had a high rate of mortality after weaning (84 %). These subadults were habituated to humans, and were killed by hunters in DLP situations away from the oilfields (R. Shideler, pers.comm. 2003). The high cub survival and high post-weaning mortality probably balanced each other and the number of bears in the region has not appreciably changed. However, recognition that anthropogenic food conditioning could have potential impacts on the bear population and endanger humans led managers to prevent access by fencing the garbage landfill and installing bear-proof garbage containers in the oilfields in the late 1990s. This was followed by the lethal removal of seven adult and subadult bears that threatened humans in 2001 and 2002.

Disturbance and displacement of grizzly bears during Alternative A operations would primarily be from road traffic between CD-2 and CD-7 and between CD-1 and CD-4, increased levels of human activity and noise at production sites, and aircraft at CD-1 and CD-3. This could include disturbing bears in winter dens. Increased traffic by local residents may increase the level of disturbance. Increased bear-human interactions with associated DLP kills could result from the Alternative A development, although controlling access of bears to garbage, as required by the BLM and the state, can minimize this impact (BLM and MMS 1998b).

Muskoxen show initial disturbance reactions to aircraft, traffic, snowmobiles, and human activity. When disturbed or threatened, muskoxen may gather together in a tight circle, charge, or run away (Miller and Gunn 1984, McLaren and Green 1985). In addition, helicopters and low-flying aircraft can cause muskoxen to stampede and abandon their calves (Winters and Shideler 1990). Muskoxen reacted when snowmobiles approached to within an average of 1,132 feet, and some animals reacted to snowmobiles when 0.6 mile away. Muskoxen reacted to larger vehicles as far as 0.8 miles away (McLaren and Green 1985). Muskoxen are most sensitive to disturbance during the winter months when they restrict their movements and activity and select a small home range with low snow cover (Reynolds et al. 2002).

Female muskoxen calve in April and May before the new vegetation emerges and must be in good body condition at calving to successfully rear offspring (Reynolds et al. 2002). Repeated disturbance to the same group of muskoxen during the late winter or early spring could have adverse effects on reproductive success and winter survival rates (BLM and MMS 2003).

Miller and Gunn (1984) observed some short- and long-term habituation to repeated helicopter overpasses at greater than 180 meters altitude. Small groups of muskoxen are frequently seen during the summer near the Dalton Highway (Nowlin 1999) and may reflect habituation to traffic. There is also evidence that muskoxen can habituate to human activity associated with oilfields. During June road surveys for caribou in 2001, a group of 25 muskoxen including 8 calves was frequently observed within 0.6 mile of roads or pads in the Milne Point Oilfield (S. Haskell, pers.comm. 2003).

Air and ground traffic associated with Alternative A may disturb muskoxen and displace them from some habitats. There are generally few muskoxen in the Plan Area, and there are alternative habitats away from the proposed roads and facility pads, thus limiting impacts. However, muskoxen use riparian zones, particularly in the winter, so the road/pipeline crossings of streams and rivers between CD-2 and CD-7 could affect the animals in the area. Also, the CD-3, and CD-4 facilities in the Colville River Delta could be a source of disturbance.

Arctic foxes have habituated to the Prudhoe Bay Oilfields and development activities (Burgess 2000). They might continue to use breeding dens even when roads or production pads are constructed nearby (Burgess 2000). Foxes have successfully raised litters within 25 meters of heavily traveled roads and within 50 meters of operating drill rigs (NRC 2003). The roads and facilities proposed in Alternative A may provide den habitat for foxes, but result in vehicle collision mortality. Access to garbage could cause increased population densities of foxes, but proper refuse management, as mandated by the BLM and the state, would mitigate this impact. If hunting and trapping occur from the Alternative A roads, fox numbers may be kept at a low level.

Potential effects on wolves and wolverines include disturbance and habitat abandonment caused by air and surface vehicle traffic and human presence (BLM and MMS 2003). If the Alternative A development changes caribou distribution, this could also alter the distribution of these predators. In addition, if the Alternative A development results in increased hunting or trapping pressure, this may also affect wolf and wolverine distribution. Because of small numbers in the Plan Area, Alternative A development within the Plan Area would likely affect few wolves or wolverines.

Obstruction to Movements

Roads with traffic and adjacent pipelines would be the primary obstructions to movements of terrestrial mammals during the operation period. Vehicle and aircraft traffic will be considerably lower during the operation period than during the construction period (Table 2.3.10-1), so this impact will be less in the operation period. Possible impacts of obstructed movements include delay of caribou moving between coastal insect-relief habitat and inland foraging areas, particularly during the mosquito season. It has been suggested that this could have negative consequences on energy balances of caribou (Smith 1996, Murphy et al. 2000) which could affect reproductive success of females and cause population declines (Nelleman and Cameron 1998, Cameron et al. 2002, NRC 2003). However, serious impacts at the population level are not apparent in the case study of the CAH in the existing North Slope oilfields. The CAH has had a large increase in numbers and high calf production during the period of oil field development (Cronin et al. 1998b, 2000, 2001).

Obstruction to movements of caribou caused by oilfield infrastructure has been described in other assessments, and these findings generally will apply here (Curatolo and Murphy 1986; Cronin et al. 1994; BLM and MMS 1998a, 2003; TAPS Owners 2001a; Murphy and Lawhead 2000; BLM 2002a). However, these studies have been primarily in the snow-free periods, and the Plan Area is used by caribou in the winter, so the potential impact of snow accumulation must be considered (Pullman and Lawhead 2002). To mitigate effects of road/pipeline corridors on caribou movements, pipelines will be elevated at least 5 feet above the ground and generally separated from roads by 350 to 1,000 feet, where feasible (see Section 2.3.2.1). These measures will provide considerable mitigation of the potential impact of obstructed movements. Separation of 350 feet may not be feasible where terrain features (e.g. lakes) constrict corridor space and where pipes and roads converge at facilities.

Factors that influence the success of caribou crossing roads and pipelines include levels of vehicle traffic, road and pipeline configuration, the size or composition of the group of caribou, insect activity, topography, snow accumulation, and learning by the caribou (Curatolo 1975, Fancy 1983, Cronin et al. 1994). The most important characteristics of pipelines with regard to animal crossing is their height above the ground and their position relative to adjacent roads. Low (less than 4 feet above ground) pipelines, such as some found in older areas of the Prudhoe Bay oilfield, can block caribou movements and may exclude caribou from some areas (Cameron et al. 1995, Murphy and Lawhead 2000). Also, pipelines in close proximity to roads tend to obstruct caribou movements. Caribou crossings were found to be significantly reduced when roads with moderate or heavy traffic was directly adjacent to an elevated pipeline (Curatolo and Murphy 1986, Cronin et al. 1994). Mitigation measures, such as elevating pipes to at least 5 feet above the ground and separating roads from pipelines by at least 300 to 500 feet generally alleviate such problems (Curatolo and Murphy 1986, Cronin et al. 1994, Murphy and Lawhead 2000). Curatolo and Murphy (1986) found that, regardless of traffic level, caribou crossing pipelines did not appear to select particular heights within the range of 5 to 14 feet above ground. Pipeline-crossing studies (Cronin et al. 1994, Curatolo and Murphy 1986, Lawhead et al. 1993) indicate that caribou movements are not obstructed by pipes elevated 5 feet above the ground, although they may more readily cross under higher pipes (Cronin et al. 1994, TAPS Owners 2001a). Gravel ramps over pipelines appear unnecessary where pipelines are elevated at least 5 feet (Cronin et al. 1994). Even though elevating pipelines allows crossings by caribou, these elevated pipes and traffic on adjacent roads may delay or deflect caribou movements to some extent before crossing. High levels of traffic (more than 15 vehicles per hour) can disrupt movements of caribou, especially when large groups aggregate during mosquito harassment (Johnson and Lawhead 1989, Smith et al. 1994, Murphy and Lawhead 2000). Burying pipelines can also enhance crossing by caribou. Crossing success can be higher at long buried sections of pipelines, particularly early in the life of a project when infrastructure is a novelty to caribou (Smith and Cameron 1985, Cronin et al. 1994). However, burying pipes within or adjacent to roadways can be expensive, may decrease safety, and can cause thermal instability of the fill and underlying substrate (Cronin et al. 1994; North Slope Buried Pipeline Study Team, 2003).

There are other factors that affect caribou movements relative to roads, pipelines, and other structures. Caribou under insect harassment are relatively insensitive to human disturbance, and will readily cross infrastructure to access relief (Ballard et al. 2000). Crossing success tends to be higher during the oestrid fly season when caribou groups are generally smaller than during the mosquito season when groups are large (Smith and Cameron 1985a, Curatolo and Murphy 1986). Also, caribou habituate to development over time and appear to have learned to navigate through oilfield infrastructure in the Prudhoe Bay region (Cronin et al. 1994, Shideler

2000, Ballard et al. 2000). When caribou are deflected by roads and pipelines, they appear more likely to cross at intersections with natural barriers such as lakes (Smith and Cameron 1985b).

Snow accumulations may effectively reduce the height of elevated pipelines. During periods of snow cover in interior Alaska, caribou crossings of the trans-Alaska pipeline were less than expected for pipe sections less than or equal to approximately 7 feet above ground (Eide et al. 1986, Carruthers and Jakimchuk 1987). Snow depths averaged 20.5 inches, and the trans-Alaska pipeline is a larger-diameter (4 feet) pipe than those proposed in the Plan Area (less than 2 feet). Differences in visual effects between pipe diameters and snow depths may alter caribou behavior and crossing success. Snow settles under and adjacent to pipelines depending on orientation of the pipeline and wind direction. On Alaska's North Slope, windward scouring and leeward deposition of snow occur around physical structures on the landscape (Li and Sturm 2002). In late spring 1982, snow under much of the 30-km east-west Kuparuk pipeline accumulated to create an impassible barrier to caribou (Smith and Cameron 1985a). Also, drifting snow around a pipeline could result in easier access to forage in wind-scoured areas beneath or windward of the pipeline. In March and April 2001, with slightly greater than annual average snow depths (about 10 inches), Pullman and Lawhead (2002) found that pipelines oriented east-west caused greater accumulation of snow than pipelines oriented north-south. Snow accumulated to significantly greater depths than controls at 25 % of sites surveyed under pipelines, and 18 % of sites had significantly less snow accumulated than control sites (Pullman and Lawhead 2002). Clearance under pipes was lowest in areas where snow accumulates naturally such as in low thaw-basins and in the lee of small-scale topographic relief. Pipelines oriented parallel to prevailing winds may cause decreased wind speeds and more settling of snow. Also, pipelines in the lee of roads may collect more snow. Higher pipes may reduce snow accumulation, and maintenance of ice roads directly adjacent to pipelines can affect snow accumulation under pipelines (Pullman and Lawhead 2002). Pullman and Lawhead (2002) found that snow depths in the Colville River Delta were less than those adjacent to the Alpine pipeline and Tarn pipeline corridors to the east. These factors suggest that snow drifting and scouring in the Plan area could result in snow accumulation under pipelines and obstruction of caribou movements. Snow drifting could make elevation of pipelines to 5 feet inadequate for animal crossings in some of the Plan Area.

Grizzly bears might avoid areas of human activity such as high-traffic roads or noisy drilling sites (McLellan 1990). Grizzly bears have been displaced from roads in Alaska, British Columbia, Montana, and Yellowstone National Park, with individual bears avoiding areas within 0.6 mile of roads in most cases (TAPS Owners 2001). There is no evidence to suggest that pipelines restrict grizzly bear movements, and some bears have been observed walking along the top of the elevated Badami pipeline (Noel et al. 2002a). It is possible that grizzly bears will experience some disturbance, but not obstruction of movements from the Alternative A development.

Muskoxen in the Colville River drainage spend the winter in the Itkillik Hills to the southeast of the Plan Area. In summer, some muskoxen (predominantly small male-dominated groups or lone bulls) travel up the Itkillik River into the vicinity of Colville River Delta and Fish and Judy creeks (Johnson et al. 1997, Burgess et al. 2002). Muskoxen generally move less than 3 miles per day, although they may move 6 miles per day between seasonal ranges (Reynolds 1992, 1998). Since reintroduction into the ANWR, muskoxen have moved west of the Colville River and are expected to continue expanding into the National Petroleum Reserve-Alaska (TAPS Owners 2001a, BLM and MMS 2003). This range expansion required crossing the Dalton Highway and trans-Alaska pipeline (it is unknown whether they crossed buried or elevated sections of pipeline) or the Prudhoe Bay and Kuparuk oilfields and suggests that muskoxen are capable of crossing roads, pipelines, and other infrastructure.

Caribou, moose, and muskoxen may occur in the Plan Area during all seasons of the year (Figures 3.3.4.1-1 through 3.3.4.1-10). Depending on the rate of vehicle traffic, movements may be obstructed by the road and pipelines from CD-1 to CD-4 and from CD-2 to CD-7. Movements may also be obstructed at the bridge over the Nigliq Channel. With both industry and local residents using the roads, traffic levels would be higher than in Alternative B in which there is no use by local residents and Sub-Alternative D in which there are no roads. Caribou generally cross roads with pipelines elevated greater than 5 feet if the roads and pipelines are generally separated by 350 to 1000 feet, as proposed in Alternative A. Previous studies suggest that the roads and pipelines in Alternative A will not obstruct caribou movements to a great extent (Cronin et al. 1994, Murphy and Lawhead 2000). However, some caribou, particularly in large groups (as may occur during summer when CAH animals move into the Plan Area) may be deflected by the road/pipelines. Caribou under insect harassment are relatively insensitive to human disturbance, and will readily cross oilfield infrastructure to access relief (Ballard et al. 2000; Cronin et al. 1999; Murphy and Lawhead 2000). Muskoxen can cross elevated pipelines, although the success of crossing with different road/pipeline configurations has not been specifically assessed (PAI 2002a). Moose are not generally obstructed by the trans-Alaska pipeline (TAPS Owners 2001a) and probably would cross roads and pipelines in the Plan Area without much difficulty. In addition, crossing of elevated pipelines without roads, such as the pipeline from CD-1 to CD-3, would probably not be impaired for caribou, muskoxen, or moose (Cronin et al. 1994). Under Alternative A, power lines would be on the pipeline VSMs (overhead on 60-foot high power poles from CD-6 to CD-7) and will not obstruct wildlife movements.

Compared with the CAH caribou which has had oilfields in its summer range for more than 20 years, TCH caribou are largely inexperienced with traversing oilfield infrastructure and associated human activities. Therefore, obstruction of movements of TCH caribou in the Plan Area could occur early in the project. Under Alternative A, the northern portion of the Colville River Delta would remain roadless, so caribou should have little problem moving there during the mosquito season. The road and pipeline from CD-2 to CD-7 could cause some short-term delay to TCH caribou over the life of the project, particularly during winter (Dyer et al. 2002). Large groups of TCH caribou (hundreds to thousands) during the mosquito season may be found northwest of the Plan Area and possibly near the coast within the Kalikpik-Kogru Rivers and Fish-Judy Creeks facility groups. Smaller groups of caribou may be present near the proposed gravel access road to CD-7 and associated production sites year-round. The largest groups of caribou in the Plan Area typically occur in the Colville River Delta when warm weather and westerly winds bring hundreds or thousands of CAH caribou westward (PAI 2002a). These caribou could be delayed in crossing the road/pipeline between CD-1 and CD-4 and between CD-2 and CD-7.

To mitigate effects of road/pipeline corridors on caribou movements, pipelines will be elevated at least 5 feet above the ground and generally separated from roads by 350 to 1000 feet, where feasible. Separation of 350 feet may not be feasible where terrain features (e.g. lakes) constrict corridor space and where pipes and roads converge at facilities.

Because caribou use the Plan Area during the winter, crossing of the road/pipeline combination at that time of year is of concern because snow accumulation may effectively reduce clearance or create a visual barrier. Because east-west-oriented pipelines could cause greater accumulation of snow than north-south-oriented pipelines, the pipeline segment from the Ublutuoch River west to CD-6 may collect more snow than the pipelines from CD-1 to CD-3 and CD-4. Thus, Alternative A (with pipelines elevated to 5 feet) may result in greater obstruction to movement in winter than Alternatives C, D, and F (with pipelines elevated to 7 feet).

Muskoxen moving into the Colville River Delta could be deflected by the pipeline to CD-3 and associated infrastructure. Muskoxen in the Ublutuoch River area could encounter the road and pipeline between CD-5 and CD-7. Reactions of muskoxen to roads with traffic and pipelines have not been studied, so these potential impacts are speculative . It is possible that roads with elevated pipelines would deflect or obstruct movements of muskoxen, as they can with caribou. However, the steady westward expansion of musk oxen suggests they can negotiate various obstacles, and it is unlikely that movements would be totally obstructed by the Alternative A Development Plan. Arctic foxes move relatively unimpeded through existing developed areas on the North Slope and would be expected to do the same in the Plan Area. The movements of red foxes and other small mammals are expected to be similarly unaffected. Movements of wolves and wolverines through the Plan Area are not well understood, but both species may avoid areas of human activity, especially where hunted (Thurber et al. 1994, BLM and MMS 2003).

Mortality

Mortality to terrestrial mammals from the Alternative A Development Plan could result from vehicle collisions, DLP kills, and increased hunting access. There are other potential causes of mortality, for example a caribou was killed after its feet were entangled in seismic cable (BLM 2004b). Vehicle collisions with all terrestrial mammals should be relatively rare with proper driver training and adherence to industry safety regulations. In addition, vehicle collisions will be less frequent in the operation period than the construction period because there will be less traffic. Vehicle collisions with wildlife have been infrequent in the Kuparuk and Milne Point oilfields over the last ten years (C. Rea, CPAI 2004, pers. comm.) However, because caribou and muskoxen may be in the Plan Area in winter, vehicle collisions can occur year-round. Increased access to the Plan Area with the new roads could result in increased levels of hunting and trapping mortality to mammals, particularly caribou, moose, musk oxen, and grizzly bears. However, local residents typically do not choose to hunt near developments (see Section 3.4.3.2).The extent of this impact depends on the intensity of hunting and trapping and regulatory harvest limits and seasons. Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality to animals can also result from surveys and capture activities (Bart 1977, Götmark 1992, TAPS Owners 2001a). Research should be designed to minimize disturbance and mortality.

With proper garbage management, as required by the BLM and stipulations and state regulations, the Alternative A Development Plan should not artificially increase the numbers of grizzly bears or foxes. In this case, increased predation on caribou, muskoxen, or moose would probably not result from Alternative A. However, the experience in the Prudhoe Bay region shows the potential impacts if food conditioning occurs. During the 1980s and early 1990s, six adult female and two adult male bears in the oilfield region fed on garbage. These females that were conditioned to eating anthropogenic food had cubs with higher survival to weaning (77 %) than did females eating only natural foods (47 %). However, food-conditioned subadults had a high rate of mortality after weaning (84 %). These subadults were habituated to humans, and were killed by hunters in DLP situations away from the oilfields (R. Shideler,pers. comm. 2003). The high cub survival and high post-weaning mortality probably balanced each other and the number of bears in the region has not appreciably changed. However, recognition that anthropogenic food conditioning could have potential impacts on the bear population and endanger humans, led managers to prevent access by fencing the garbage landfill and installing bear-proof garbage containers in the oilfields in the late 1990s. This was followed by the lethal removal of seven adult and subadult bears that threatened humans in 2001 and 2002.

Controls on feeding wildlife in the Plan Area as outlined by the BLM and MMS (1998b) are designed to prevent bears and foxes in the Plan Area from becoming food-conditioned, to minimize human-wildlife interactions, and to prevent DLP killings. Strict adherence to these policies and rigorous monitoring should minimize the potential for food conditioning bears and foxes. Although these policies have been in place in the existing oilfields, violations may occur and complete effectiveness is difficult.

The increased presence of oilfield workers increases the probability of human-bear encounters and DLP kills, even if there is no food conditioning and the bear numbers do not increase (NRC 2003, BLM and MMS 2003). In addition, the biggest impact of new developments on grizzly bears can be increased access by hunters that results in increased legal and illegal harvest and DLP kills due to improper garbage control by hunters. On the North Slope, grizzly bears are especially susceptible in the spring, when snow makes them visible and allows hunters to use snowmobiles. The road system developed under Alternative A may provide some increased access for hunters.

There may also be increased human-fox contact. The presence of rabies in foxes may result in control actions that kill foxes. Wolves are scarce but would likely avoid human activities in this area and would not directly experience increased mortality as a result of Alternative A. However, under Alternative A, roads would be open to local residents, potentially increasing hunting and trapping mortality to wolves, wolverines, and other species.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities will disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance would be less than during construction, however, because caribou, muskox, and other terrestrial mammals are likely to have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals may be killed by collisions with road traffic. If roads are left in place and maintained in useable condition upon abandonment, they may continue to provide improved access to hunting areas with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the CD-3 airstrip left in place will facilitate restoration of habitat. Because plant communities on these raised gravel structures may be different from those that prevail in adjacent areas, the habitat will differ from that which currently prevails. However, pads, roads, and the CD-3 airstrip, if left in place may furnish some insect relief for caribou. If gravel fill is removed and the pad revegetated with vegetation similar to that which surrounds it, caribou and possibly other terrestrial mammals will use it (Kidd et al. 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal and used by fox as denning material. Depending on the material's toxicity and the amount ingested by kits, this could cause mortality, though the numbers are likely to be very small. Overall impacts of abandonment and rehabilitation activities would be measured as impacts to individuals; no adverse impacts to populations are expected.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT IMPACTS ON TERRESTRIAL MAMMALS

Alternative A – FFD is shown in Figure 2.4.1.2-1. The amount of gravel fill under Alternative A would be approximately 1,262 acres. Because neither detailed site locations nor habitat mapping are available, we cannot quantify specific terrestrial mammal habitat lost under Alternative A. However, more acreage is covered with gravel in Alternative A than in Alternatives B and D. In Alternative A, a large portion (66 %) of gravel fill would be roads.

COLVILLE RIVER DELTA FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

In the Alternative A FFD Plan scenario, direct habitat loss to gravel fill in the Colville River Delta Facility Group other than described in the ASDP would include roads to access HP-4 and HP-5 as well as gravel for seven production pads. Four of the sites on the northern half of the Delta (in addition to CD-3) would be without roads but would also require gravel fill for airstrips and connecting pipelines. This gravel fill would result in the loss of potential forage for caribou, muskoxen, and moose. Winter ice roads would also cover potential forage during that time of year. The amounts of forage lost would be small relative to that available throughout the area. The increased number of gravel pads, roads, elevated pipelines, and structures would provide some insect-relief habitat, including shaded areas.

The impacts to habitats of other terrestrial mammals would be similar to those described previously in the section on the CPAI Development Plan but would be over the larger FFD area. This includes loss of tundra habitats under gravel fill and increases in potential den sites for foxes. It is unlikely that the amount of habitat for any terrestrial mammal would be significantly increased or decreased to the extent that it would affect the numbers of animals occurring in the Plan Area.

Disturbance and Displacement

The construction phase of FFD would take place primarily during winter months but over a longer time period than the ASDP, so there is the potential for longer-term disturbance to terrestrial mammals. Caribou do not occur frequently in the winter in the Colville River Delta, so disturbance during construction and winter operation should be limited. Denning grizzly bears are subject to disturbance in winter, and this may happen during FFD. Similarly, industry-related disturbances during operation on calving caribou would be minimal because few caribou are in the Colville River Delta during this time. During the post-calving season, some caribou could be disturbed by operations when large numbers of animals move into the area. However, the lack of roads would remove potential effects of vehicle traffic. Air traffic would result in some disturbance of caribou in the area during the summer. Moose, muskoxen, and grizzly bears could be disturbed somewhat during the summer months. This disturbance may be exacerbated by increased traffic from local residents, who could use the roads associated with the new development, such as those to hypothetical pads HP-4, HP-5, and HP-8.

Obstruction to Movements

During the winter construction phase of FFD, traffic on ice roads could obstruct movements of caribou. However, winter densities of caribou are low in the Colville River Delta (Figure 3.3.4.1-5) (BLM and MMS

2003), so this impact would be limited. Construction during FFD also has the potential to affect the movements of moose and muskoxen in the Colville River Delta Facility Group, but both of these species usually winter to the south of the Plan Area (Burgess et al. 2002, BLM and MMS 2003). Few caribou occur in the Colville River Delta Facility Group during calving, so obstruction of movements from operations would be minimal at that time. However, large numbers of caribou may move into the Delta during the post-calving season. Moose and muskoxen also use the Colville River Delta during summer. Most FFD in the Delta, especially in the northern portion, would include only pipelines without roads to the CD-3, HP-7, HP-12, HP-13, and HP-14 facilities. These pipelines would be elevated to 5 feet and, without associated roads, should allow free passage of caribou. Roads/pipelines to HP-4, HP-5, and HP-8 may obstruct local movements to some extent, but as discussed previously, elevated pipes usually allow passage of caribou. Overall, the limited number of roads in the Alternative A FFD Plan would limit the extent of obstruction of movements of terrestrial mammals in the Colville River Delta.

Mortality

Road kills should be few in the Colville River Delta Facility Group because there are few caribou, muskoxen, or moose present in winter when much of the construction would occur, and there are no roads to the production sites during operations in the northern part of the area. Some vehicle-caribou collisions could occur during summer along the roads to HP-4, HP-5, and HP-8. There is potential for increased human-bear encounters and exposure to foxes at FFD production sites. This may result in mortalities of these species.

FISH-JUDY CREEKS FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

The Alternative A FFD Plan would have additional roads and pads in the vicinity of Fish and Judy creeks. This would cover more habitat than the ASDP alone. Habitats directly lost for foraging activities are as described previously in the CPAI Development Plan Impacts section. However, the proportion of habitat to be covered is small relative to that in the entire area. Terrestrial mammals in the Plan Area would likely not experience a major loss of habitat as a result of gravel placement. Caribou might selectively use elevated gravel sites as insect-relief habitat, and areas near infrastructure for foraging where plant phenology might be altered and forage could remain available later in the year. Effects of habitat alteration on terrestrial mammals would be the same as described in the ASDP section but over a larger area and over a longer period of time.

Disturbance and Displacement

There is the potential for disturbance and displacement of caribou and other terrestrial mammals in the Fish-Judy Creeks Facility Group, as in the CPAI Development Plan areas. The production facilities and road/pipelines connecting them throughout the area may impose new disturbance on caribou during the summer and winter. The level of impact would probably be greatest during the construction periods and would depend on levels of vehicle traffic in summer and winter. This is not a major caribou calving area, but traffic on roads could displace some of the calving caribou that are present.

The experience in existing oilfields as described previously in the ASDP sections suggests that caribou would not abandon or avoid FFD in the Fish-Judy Creeks Facility Group as summer habitats. As FFD progresses and TCH caribou are exposed to oilfield disturbance, habituation might proceed as with the CAH caribout. However, if hunting were to take place near FFD oilfields, habituation might not occur and avoidance of human activities could increase.

Disturbance and displacement of grizzly bears, muskoxen, moose, wolverines, and wolves can be expected to be similar to that described for the CPAI Development Plan Alternative A, but under FFD disturbance and displacement would be spread across a broader area. Development in riparian habitats such as those near Judy Creek and Fish Creek can be expected to have a proportionally greater impact on these species, because they are often associated with those habitats. Road access for hunters and trappers has the potential to increase negative effects of road development in the Fish-Judy Creeks Facility Group.

Obstruction to Movements

The Fish-Judy Creeks Facility Group is in the eastern part of the TCH caribou range, and many animals of the TCH use this area. Densities of overwintering caribou have been highest in the past near the Ublutuoch River by the prospective HP-10 and HP-11 sites in the Fish and Judy creeks area (Figure 3.3.4.1-5) (BLM and MMS 2003). Considerable numbers of caribou have also used the northern portion of the Fish and Judy creeks area during the summer (Figure 3.3.4.1-3 and Figure 3.3.4.1-4). The HP-15, HP-1, and HP-3 production pads and road/pipelines connecting them could obstruct caribou movements, although pipelines will be elevated to 5 feet and separated from the road generally by 350 to 1000 feet, where feasible. Some TCH caribou might selectively use riparian areas such as Fish Creek and Judy Creek during the oestrid fly season (Burgess et al. 2003). The proposed gravel access roads to the hypothetical HPF-1 and HP-19 sites would cross Fish and Judy creeks and parallel Judy Creek. Temporary obstructions to movements of some caribou could be expected, and caribou also could use infrastructure for insect-relief habitat. Increased traffic on the roads from local residents and industry use may cause some obstruction if at high enough levels. Small numbers of calving caribou have occurred in the Fish-Judy Creeks Facility Group area (Figure 3.3.4.1-6), so impacts during the calving period would be limited.

The greatest density of caribou reported in the Plan Area in recent years was in July 2001 when about 6,000 CAH caribou moved west through the area of Fish and Judy creeks in response to warm temperatures and westerly winds. CAH caribou would probably be more experienced at crossing oilfield infrastructure than TCH caribou, especially early in the life of the project. Roads and pipelines near riparian areas may disproportionately affect movements of large mammals other than caribou such as bears, moose, and muskoxen compared to similar infrastructure situated away from riparian areas. However, densities of these mammals are low and alterations of movements should be temporary.

Local and temporary obstruction of movements caused by roads and pipelines can be expected to be similar to that described for the ASDP, but construction of a more fully developed oilfield can create additional issues associated with larger-scale obstructions. Smith et al. (1994) reported that early in their study, large groups of insect-harassed caribou approached the central portion of the Kuparuk Oilfield, but by the end of their study, large groups of caribou primarily approached only the edges of their study area, indicating that caribou avoided the center of activity.

Mortality

Accidental deaths from vehicle collisions should remain uncommon but would probably be proportionally greater by road length than in the CPAI Development Plan. Existing traffic restrictions and personnel training in existing oilfields mitigate occurrences of vehicle strikes in oilfields. Garbage control in the FFD should prevent increases in predator numbers that could potentially affect caribou and muskoxen. In Alternative A, local residents would have access to roads. If hunting were to be allowed from the road system, mortalities of terrestrial mammals in the FFD could increase. This could be managed by federal or state hunting regulations. During difficult winters, disturbance and displacement of muskoxen from riparian areas, overwintering caribou, or bears from dens could cause winter mortality or reduce calf survival in the spring.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

The Kalikpik-Kogru Rivers Facility Group would have four production pads and one processing facility connected by pipelines and roads under Alternative A – FFD Scenario (Figure 2.4.1.2-1). Some habitat would be lost under gravel, as described in the section about the CPAI Development Plan. However, the proportion of habitat that would be covered is small compared to that in the entire area. Terrestrial mammals would likely not experience serious range limitation as a result of gravel placement. In addition, habitat enhancement could occur, because caribou might use elevated gravel sites as insect-relief habitat. Effects of altered habitats would be the same for terrestrial mammals as described in the ASDP section but would occur over a larger area and over a longer period of time.

Disturbance and Displacement

Densities of calving caribou are expected to be greatest near the Special Caribou Stipulations Area in the northwest portion of the Kalikpik-Kogru Rivers Facility Group. This is particularly the case near prospective HP-21 and the processing facility HPF-2, which are in the calving area of the TCH caribou (Figure 3.3.4.1-2) (BLM and MMS 1998a, 2003; Jensen and Noel 2002). Because of this, the BLM and MMS (1998b) outlined specific mitigation stipulations for development and operations in this area.

The access road and pipeline from HPF-2 to HP-21, the pipeline from HP-21 to HP-22, and the air traffic at HP-22 may disturb calving caribou, but stipulations limiting vehicle and air traffic would minimize disturbance. The TCH caribou are not experienced with oilfields, and disturbance may be greatest during the first year of operations. Disturbance of caribou during summer and winter could also occur locally as described previously in the CPAI Development Plan section, but potential impacts could be mitigated by controlling traffic and human activity. However, during difficult winters, disturbance could have adverse effects on survival of overwintering caribou and muskoxen and on calf viability in the spring.

Obstructions to Movement

Densities of caribou in all seasons have been high in the area of the Kalikpik and Kogru rivers compared to the other parts of the Plan Area (BLM and MMS 2003, Prichard et al. 2001). The roads/pipelines and facilities may impede movements during any time of the year, although as described previously for the CPAI Development Plan, caribou usually cross pipelines and roads like those designed for Alternative A. Moose and muskoxen are uncommon in this facility group area, so impacts to these species would be limited.

Mortality

Accidental deaths of terrestrial mammals from vehicle collisions in the Kalikpik-Kogru Rivers Facility Group would likely be uncommon if caution is taken. Existing traffic restrictions, including BLM stipulations and personnel training, mitigate vehicle collisions in oilfields. Like the CPAI Development Plan, development should have little or no impact on predator densities if garbage is managed properly and intentional feeding is prohibited, as required by BLM stipulations. In Alternative A, local residents would have access to roads. If hunting were allowed from the road system, mortalities could increase.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON TERRESTRIAL MAMMALS

The CPAI Development Plan Alternative A would involve the changing of habitats used by terrestrial mammals in several ways. An estimated 241 acres of undeveloped land would be covered with gravel fill and approximately 65 acres would be excavated to obtain the gravel. This is a small %age of the land in the Plan Area. The amount of habitat types preferred by caribou, muskoxen, and moose that would be affected by this fill is a small proportion (less than 0.1 %) of that available in the Plan Area. Alternative A would result in a small direct loss of terrestrial mammal habitat.

Construction and operations would cause some disturbance of terrestrial mammals. Disturbance could in turn displace mammals from preferred habitats. Noise and human activity associated with construction, industry vehicle traffic, aircraft traffic, and activity on facilities and pipeline routes during operations could disturb caribou, moose, muskoxen, and grizzly bears in the vicinity of infrastructure. This could cause animals to be displaced from infrastructure. Displacement is most likely early in the life of the project because some habituation is likely over time. Disturbance of caribou (and probably also moose and muskoxen) is most likely for 2 to 3 weeks around the calving period in late May to early June. Because the CPAI Development Plan does not extend westward enough to include the primary calving areas of the TCH caribou, as long as the calving range remains west of the development area, Alternative A would have little or no disturbance impact on calving caribou. During the summer post-calving period and winter, caribou are less sensitive to disturbance and would probably habituate to industry infrastructure and activity. However, access to the developed area by local residents may considerably increase the amount of disturbance to caribou, moose, muskoxen, and grizzly bears during summer and winter if hunting is allowed.

There would be 26 miles of road/pipeline and an additional 10 miles of pipeline without a road under CPAI Development Plan Alternative A. Pipelines would be elevated 5 feet and generally separated from roads by 350 to 1,000 feet, where feasible. This should allow passage of caribou and other terrestrial mammals. The road/pipeline combination may delay or deflect caribou crossing, especially if traffic levels are more than 15 vehicles per hour. If local hunting occurs on the roads, crossing may be impeded because of increased avoidance of human activity.

Mortality of terrestrial mammals directly caused by the Alternative A development would probably be limited to occasional road kills and DLP killing of bears. Hunting by local residents on the oilfield roads would increase the mortality of caribou and possibly of moose, muskoxen, and grizzly bears.

All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative impact at the population level. The experience in existing North Slope oilfields shows that populations of terrestrial mammals (most notably caribou) have grown or remained stable since initiation of development. The inclusion of local access to, and possibly hunting in, the Alternative A development could cause disturbance and mortality that affects the population. However, the past harvest levels of caribou, muskoxen, and moose by the local community are a small enough proportion of the populations that negative impacts are unlikely if proper mitigation and regulations are enforced. In fact, harvest is a primary tool of wildlife managers, for example, to keep a population at a level compatible with available habitat. A positive aspect of increased hunter access is that it could allow more control over hunting harvest if managers would have more ability to increase harvest when necessary. However, the local residents typically choose not to hunt around developed areas.

Impacts from the Alternative A FFD would have the same effects described for the CPAI Development Plan, but over a larger area. An exception is the potential for increased disturbance of calving caribou of the TCH in the northwestern part of the Plan Area.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR TERRESTRIAL MAMMALS

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

PREDATORS

- Communications among CPAI, local residents, the NSB, the State of Alaska, and federal agencies can minimize conflicts and accidents related to activities in the Plan Area, including hunting by local residents.
- A management plan for bears and other predators (e.g., foxes, ravens, gulls) should be developed that addresses the proper methods of food and garbage storage at drill sites, processing facilities, construction sites, water withdrawal sites, and other operational sites. Bear-proof and fox-proof garbage and food containers and regulations to prohibit careless treatment of garbage and food should be implemented. Site design can incorporate features that reduce the risk of attracting or confining polar bears or grizzly bears and allows effective detection and hazing of bears. A bear safety awareness program for employees and contractors should be developed.
- Fox denning in culverts and other structures can be discouraged by inspection and removal or structure design.

HERBIVORES

- Pipelines should be elevated more than 5 feet to allow unimpeded crossings by caribou. Greater elevation (e.g., 7 feet) could enhance crossing success in some cases (Eide et al. 1986, PAI 2002a, Cronin et al. 1994).
- Pipelines and roads with traffic should be separated by more than 300 feet where possible. This enhances caribou crossing success (PAI 2002a, Murphy and Lawhead 2000, Curatolo and Reges 1986, Cronin et al. 1994). The success of animals trying to cross pipelines adjacent to roads with more than 5 vehicles per hour was reduced if the pipelines and roads were separated by less than 328 feet (100 meters) (Curatolo and Reges 1996). These results led to recommendations of separation of roads and pipelines by 400 to 500 feet for efficient crossing success (PAI 2002a, Cronin et al. 1994).
- Sections of pipeline can be buried to enhance crossing success of caribou, muskoxen, and moose. Caribou have shown selection of long, buried pipeline sections (average length 1.1 km) when crossing the trans-Alaska pipeline (Eide et al. 1986, Carruthers and Jakimchuk 1987, Cronin et al. 1994, TAPS Owners 2001). Moose did not show a preference for long buried sections. Neither caribou nor moose showed a preference for short (less than 18.3 meters) “sagbend” buried sections. Long buried sections of pipeline could be included in all six alternatives, but it may be most useful in Alternatives A and C, where there are long sections of pipeline/road combinations. Because the Plan Area is used by caribou in the winter, buried sections of pipeline may mitigate the potential barrier effect from snow drifting near pipelines in all of the alternatives. The observations of large numbers of caribou moving across the area of Fish and Judy creeks and across the Colville River Delta in the summer suggest placement of buried sections between CD-2 and CD-7 for Alternatives A and C might be appropriate. For Sub-Alternative C-1, buried sections between CD-1 and CD-3 could mitigate crossing the pipeline/road combination in that area. CPAI and management agencies should consult to determine if buried sections of pipeline are necessary and what specific locations and lengths of buried pipeline sections should be used. It should be noted that buried pipelines have serious limitations due to high cost, identification of and repair of corrosion and leaks, and melting of surrounding permafrost (North Slope Buried Pipeline Study Team 2003).
- Vehicle traffic can be restricted to groups of vehicles traveling in convoys, instead of unrestricted traffic. This may be appropriate during and immediately after calving periods in some areas, although it appeared that convoys were not particularly effective in reducing calving disturbance and displacement at the Meltwater Project, east of the Colville River (Lawhead et al. 2003). Closing roads to all vehicle traffic during the calving period when animals are present could also be an effective mitigation measure. Restrictions of aircraft size and flight frequency and flight paths and altitudes may also mitigate potential impacts on calving caribou, muskoxen, and moose. Currently, caribou calving is restricted to the western part of the Plan Area. If this range extends east or if the FFD proceeds to that area, such restrictions may be appropriate.
- Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality can result from surveys and capture activities (Bart 1977, Götmark 1992, TAPS Owners 2001a). Research should be designed to minimize disturbance and mortality.

ALTERNATIVE A –EFFECTIVENESS OF PROTECTIVE MEASURES FOR TERRESTRIAL MAMMALS

The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations 5 a, b, c, and d, 14, 15, and 16 regarding solid- and liquid-waste disposal, fuel handling, and spill cleanup are expected to reduce the potential effects of spills and human refuse on grizzly bears and other terrestrial mammals. Stipulation 34 assists in movement of wildlife by calling for the 500-foot separation of roads and pipelines. Stipulation 55 that requires aircraft to maintain 1,000 feet above ground level (AGL) (except for takeoffs and landings) over caribou winter ranges from October through May 15 is expected to minimize disturbance of caribou. Additional potential mitigation identified in this EIS regarding pipeline height, road and pipeline separation, burial of portions of above ground structures, and traffic management is expected to reduce impacts to caribou movements.

4A.3.4.2 Marine Mammals

Development activities within the Plan Area that could affect marine mammals include construction of roads, pads, airstrips, and pipelines; facility operation; and vehicle and aircraft traffic. Impacts from construction activities and during operations would be primarily from noise from vehicle and aircraft traffic. Noise propagation and measurement and the reactions of marine mammals to noise have been described previously (Richardson et al. 1995, USACE 1999, Richardson et al. 2002). Attractants for polar bears, such as garbage, may be generated by human activities during all phases of development. However, this would be mitigated with proper waste management. Ringed seals, bearded seals, and polar bears remain in the vicinity of the Plan Area during the winter months and might be present during construction of the project. During summer, beluga whales, spotted seals, and other marine mammals might also be present.

Oil spills also could directly or indirectly affect marine mammals in the Plan Area. Potential oil and chemical spills in the Plan Area are described in Section 4.3.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON MARINE MAMMALS

RINGED SEAL AND BEARDED SEAL

Construction Period

Habitat Loss, Alteration, or Enhancement

All roads, pads, airstrips, and pipelines would be constructed during the winter. None of the development infrastructure proposed under Alternative A is in or near ringed or bearded seal habitat, so there would be no impacts to those species.

Disturbance and Displacement

Neither aircraft nor vehicular traffic to any sites would likely have serious impacts to ringed seals or bearded seals. Noise from vehicular traffic using an overland ice road to CD-3 or construction activity is not expected to propagate into seal habitat and would not affect seals.

Several round-trips per day by fixed-wing aircraft from Deadhorse-Prudhoe Bay and/or the existing airstrip at CD-1 to the proposed airstrip at CD-3 would be a potential source of disturbance to seals hauled out on the ice in spring. Aircraft would be expected to maintain an altitude greater than 1,000 feet over water under the MMPA, except upon takeoff and landing. At such elevations, the potential for disturbance to seals would be greatly reduced. Flight elevations of less than 1,000 ft are anticipated to be over land areas within 3.6 miles northeast and southwest of the airstrip at CD-3. Moulton et al. (2003) reported that there were no negative reactions to surveys flown at 300 feet, and only 1.5 % of the observed seals dove into their holes in response to the aircraft. Other flights by fixed-wing aircraft or helicopters supporting construction could disturb or displace seals from their haulouts. The number of seals affected would depend on the frequency of flights over the Beaufort Sea seal habitat. Aircraft routes are not expected to pass over seal pupping habitat, so no impacts to seal pups are expected.

Obstructions to Movement

Construction of Alternative A facilities would not result in any obstruction to movements of ringed seals and bearded seals.

Mortality

Construction of Alternative A facilities would not result in any mortality to ringed seals and bearded seals except as the result of possible oil spills.

Operation Period

Habitat Loss, Alteration, or Enhancement

No ringed seal or bearded seal habitat alteration is expected, except as a result of possible oil spills.

Disturbance and Displacement

Some disturbance and displacement of ringed seals and bearded seals during the operation period could occur from aircraft noise. Ringed seals follow the edge of the retreating pack ice north during summer, so few ringed seals are expected to be in the Plan Area during summer. Those ringed seals that remain may be displaced for a short time by aircraft noise, but any effects are expected to be uncommon and of less than 1 hour duration. Flights that go over the ice edge could affect seals there. Breathing holes, lairs, and haulouts of ringed seals are often found away from lead edge habitat. The anticipated flight path for the airstrip at CD-3 would be over land areas in the Colville River Delta. Maintaining a 1,000-foot minimum altitude would minimize effects on ringed seals at these sites.

Operation of production facilities is not expected to affect bearded seals, because noise from operations would not propagate into bearded seal habitat. Fixed-wing aircraft and helicopters could disturb a small number of bearded seals hauled out along shore and pack ice edges during the spring and summer. However, bearded seals generally prefer areas of less stable or broken sea ice (Cleator and Stirling 1990). Noise from airplanes or helicopters could displace bearded seals into the water for a short time. However, aircraft are expected to maintain an altitude greater than 1,000 feet over water under the MMPA and flight paths are not anticipated over water or ice. Therefore, only a few bearded seals might be affected for short durations annually. Maintaining flight paths away from lead edge habitat would mitigate impacts to bearded seals.

Obstructions to Movement

Alternative A operations would not result in any obstruction to ringed seal and bearded seal movements.

Mortality

Alternative A operations would not result in any direct mortality to ringed and bearded seals, except as the result of potential oil spills.

SPOTTED SEALS

Spotted seals regularly use the main channel of the Colville River and Nigliq Channel in summer. Therefore, production activities on the Colville River Delta have greater potential to affect spotted seals than ringed seals or bearded seals. Johnson et al. (1998, 1999) found spotted seals only in the East Channel of the Colville River, at the mouth of the Kachemach River, and on the southwest end of Anachlik Island. Local residents of Nuiqsut report that spotted seals regularly use Nigliq Channel and the Fish and Judy creek deltas (Morris 2003, pers. comm.). Spotted seals have been observed as far upstream as Ocean Point and occur regularly as far as the mouth of the Itkillik River (Reed 1956; Seaman et al. 1981).

Construction Period

Habitat Loss, Alteration, or Enhancement

Alternative A includes construction of a 1,200-foot-long bridge across the Nigliq Channel to connect National Petroleum Reserve-Alaska sites CD-5, CD-6, and CD-7 to CD-2. The bridge across Nigliq Channel has the potential to alter spotted seal haulout habitat on gravel or sand bars in the river through changes in the flow of the river that could change the deposition of sand within the channel. The number of spotted seals affected would depend on the amount of habitat alteration that occurs and the number of seals using the area. The severity of the disturbance depends on the proximity of other suitable haulouts. However, effects to individual seals are likely to be short duration (less than 1 year) and are not expected to result in injury to any spotted seals.

Disturbance and Displacement

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not disturb or displace spotted seals. However, spring or summer construction in the vicinity of the rivers could disturb spotted seals. The extent of displacement would vary depending on the type of construction activity, the behavior and activity state of the seals, the proximity of the seals to the construction activity, and other known and unknown factors.

Obstructions to Movement

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not obstruct spotted seal movements. However, spring or summer construction could block movements of seals up and down the rivers. The extent of obstruction would vary depending on the type of construction activity, the behavior and activity state of the seals, the proximity of the seals to the construction activity, and other known and unknown factors.

Mortality

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not cause any spotted seal mortality. With the exception of the results of possible oil spills, spring or summer construction would not cause mortality.

Operation Period

Habitat Loss, Alteration, or Enhancement

The construction of bridges could alter habitats as described above. No additional habitat alterations are expected during operations, with the exception of the results of possible oil spills.

Disturbance and Displacement

Vehicle traffic across the bridge over Nigliq Channel could disturb spotted seals hauled out on sand or gravel banks nearby. Noise from vehicle traffic could displace a small number of seals from haulouts on sand or gravel bars near bridges. However, a large volume of traffic on the roads during operations is not anticipated. The number of seals affected would depend on the proximity of the bridge to any haulouts, and the number of seals on the haulouts. Impacts to individual seals are expected to be short-term and are not expected to result in injury to any spotted seals.

Aircraft traffic in the Plan Area is also a potential source of disturbance to spotted seals hauled out on sand or gravel bars during the summer. The approach trajectories for aircraft include a path over the Nigliq Channel, and planes may approach across the main channel coming to or from Deadhorse. Overflights by fixed-wing aircraft could cause the temporary displacement of seals from the haulouts. Under the MMPA, aircraft are expected to maintain an elevation greater than 1,000 feet over water, except during takeoff and landing. At 1,000 feet, the potential for disturbance to seals is greatly reduced. Johnson et al. (1998) reported no reaction of seals to surveys flown at altitudes of 255 to 705 feet but reported reactions (seals entering water) when the plane circled the haulouts at those altitudes. However, when aircraft are at low altitude during takeoff and for landing, the potential for disturbance increases. The number of seals affected would depend on the number of takeoffs and landings and the number of seals on the haulouts. Displacement of hauled out seals is not likely to result in injury to any seals, and they could habituate to the noise.

Obstructions to Movement

Facility operations in Alternative A are not expected to obstruct movements of spotted seals, although it is possible that seals will hesitate before crossing under bridges.

Mortality

Alternative A operations are not expected to cause any mortality of spotted seals, except as the result of possible oil spills. If access for hunters increases, mortality could increase.

POLAR BEARS

Polar bears are present in the Plan Area throughout the year. Males and non-pregnant females may be active on the ice and onshore throughout the year, while pregnant females could den in the Plan Area.

Construction Period

Habitat Loss and Alteration

Parts of the Plan Area are polar bear habitat; some polar bear denning habitat may be lost as a result of construction activities. Stipulations require that construction activities under Alternative A not occur within 1 mile of known or suspected polar bear dens. Adhering to this stipulation could reduce loss of habitat.

Disturbance and Displacement

Construction of roads, pads, and pipelines is a potential source of disturbance for polar bears in the Plan Area. Female polar bears denning within approximately 1 mile of the construction activity could be disturbed by vehicular traffic or construction noise. Disturbance of females in maternity dens could result in either abandonment of the cubs or premature exposure of cubs to the elements, resulting in mortality (Amstrup 1993). Few dens have been located in the Plan Area in the last 10 years, although bears are known to occasionally den in the area (Figure 3.3.4.2-1). Regulations require that road and other construction activities maintain a 1-mile buffer around known or suspected polar bear dens. MacGillivray et al. (2003) measured noise from industrial activities in artificial dens at varying distances from the activity. Noise in the dens from vehicular traffic was generally at background levels when vehicles were approximately 500 meters away. However, one vehicle was detectable above background levels at a distance of 2,000 meters. Thus, current regulations should prevent disturbance to polar bears in natal dens that have been identified. Bears in unidentified dens could be disturbed by the construction of roads, pads, or pipelines. The number of bears affected would depend on the number of dens that are undetected but within a 1-mile buffer around construction activity. The severity of the effect would depend on the reaction of individual bears, whether the den is abandoned, and the age of the cubs when the disturbance occurs.

Aircraft traffic to and from the Plan Area could also disturb polar bears in dens. MacGillivray et al. (2003) reported that helicopters were the loudest vehicles recorded during their study, and that sound was only minimally attenuated by distance and through the snowpack. Fixed-wing aircraft also can disturb denning bears. The number of bears affected would depend on the number of polar bear dens in flight paths. As with other noise impacts, the severity of effects would depend on the reaction of individual bears, whether the den is abandoned, and the age of the cubs.

Aircraft traffic may also disturb non-denning polar bears in the Plan Area. Non-denning polar bears often react to low-flying aircraft by running away. Helicopters are sometimes used to scare bears away from human habitation (Richardson et al. 1995). The number of bears affected would depend on the number of bears that are near aircraft flightpaths. Effects would be limited to displacement for a short time.

Non-denning polar bears may avoid the immediate vicinity of construction activities or they may be attracted to it, depending on the circumstances and temperament of individual bears. Avoidance of the area would reduce the potential number of human-bear interactions, thereby reducing the potential for injury to people or the need to kill bears.

Obstructions to Movement

No obstructions to polar bear movement are expected as a result of CPAI Development Plan Alternative A construction.

Mortality

No polar bear mortality is expected as a result of Alternative A construction. However, human-bear conflict, oil spills, or increased hunting access could result in mortality. Attraction to the area would increase the potential for human-bear interactions, and may result in the death of the bear in DHP. However, such actions have been rare (Federal Register 68(143)44028); only two polar bear deaths related to oil and gas have occurred in the past, and such deaths are not expected to be common in the Plan Area. Training of oilfield workers and regulations such as those already in place for other arctic developments would be helpful in minimizing bear-human conflicts. Thus, interactions between humans and bears are expected to be few and of short duration.

Operation Period

Habitat Loss, Alteration, and Enhancement

The facilities for Alternative A could cover potential denning habitat. However, alternative denning habitats are likely available in the Plan Area and adjacent areas. Bears have denned on inactive gravel pads, so new den sites could be available in the future.

Disturbance and Displacement

In general, potential impacts to polar bears during the operation period are similar to those described for construction. These impacts would be primarily from noise from vehicles, facilities, and aircraft that could affect non-denning or denning bears. Polar bears in the Beaufort Sea seldom venture onto land (Amstrup 2000) and are unlikely to be found in the Plan Area during summer. They are therefore unlikely to be affected by operations activities that occur during the summer.

Obstructions to Movement

No obstructions to polar bear movement are expected as a result of operations under Alternative A.

Mortality

No polar bear mortality is expected as a result of operations under Alternative A. However, human-bear conflict, oil spills, or increased hunting access could result in mortality, as described for the construction period.

BELUGA WHALES

Beluga whales could be present offshore of the Plan Area in low numbers during the summer. Belugas pass near the Plan Area during their fall migration from the eastern Beaufort Sea to their wintering grounds in the Bering Sea, but few probably pass through Harrison Bay. Treacy (1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2002a, 2002b) detected small numbers of belugas in Harrison Bay during aerial surveys conducted during the fall bowhead whale migration. Most belugas pass north of a line from Cape Halkett to Oliktok Point during migration. During the spring migration, nearshore waters are ice-covered and belugas stay far offshore of Harrison Bay in the lead system.

Construction Period

Habitat Loss, Alteration, or Enhancement

Construction of the bridge over the Nigliq Channel would modify habitat at that site. Construction activities at that site would not likely have large impacts on beluga whales because much of the construction activity will take place during the winter when belugas are not present in the Plan Area.

Disturbance and Displacement

Beluga habitat is primarily in the Beaufort Sea, and no impacts from construction are expected there with the exception of possible oil spills. Construction of the bridge over the Nigliq Channel could change stream conditions and affect the few belugas that go there.

Obstructions to Movement

Construction of facilities under Alternative A would not obstruct movements of beluga whales.

Mortality

Construction of facilities under Alternative A would not cause beluga whale mortality except as the result of possible oil spills.

Operation Period

Habitat Loss, Alteration, or Enhancement

The 1,200-foot bridge over the Nigliq Channel of the Colville River has the potential to affect beluga whales in the Nigliq Channel. Nuiqsut residents report that belugas occur in the Nigliq channel and main channel of the Colville River and in the Fish Creek Delta (Morris 2003, pers. comm.). Bridge supports in the Nigliq Channel could affect beluga navigation of the channel if water flow and deposition of sand or gravel is altered. The number of belugas affected would depend on how many enter the Nigliq Channel.

Disturbance and Displacement

Operations during the summer would not affect belugas in the Beaufort Sea, because noise from facilities is not expected to propagate there. Vehicle traffic over the Nigliq Channel bridge may create noise that could affect belugas near the bridge. Such impacts are expected to be short term, short distance displacement and are not expected to result in injury to any whales. Aircraft traffic over the Nigliq Channel could affect beluga whales in the Plan Area. Beluga whales respond to aircraft differently depending on the context of their social group, environmental conditions, and aircraft altitude (Richardson et al. 1995). Feeding groups of belugas appeared to be less prone to disturbance by an aircraft at 1,640 feet altitude than are lone animals (Bel’kovich 1960 in Richardson et al. 1995). Inupiat hunters suspected that low-flying aircraft were responsible for preventing belugas from entering a bay along the Alaskan Beaufort Sea coast (Burns and Seaman 1985). The number of whales that might be affected would depend on the number of whales using the Nigliq Channel. There are no estimates of the number of whales using Nigliq Channel. Reports indicate belugas commonly occurred near the shorefast ice in the Colville Delta region until ice moved offshore (Helmericks, pers. comm., cited in Hazard 1988). The severity of the effect would depend on the conditions described above, but impacts are expected to be short-term and are not expected to result in injury to any whales.

Obstructions to Movement

No obstructions to beluga whale movements are expected as a result of facility operations under Alternative A. It is possible that activity on the Nigliq Channel bridge would delay belugas, but few probably go up the channel.

Mortality

No beluga whale mortality is expected as a result of operations under Alternative A, with the exception of that caused by possible oil spills and increased hunter access.

ABANDONMENT AND REHABILITATION

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction. Aircraft flights could disturb ringed or bearded seals and non-denning polar bears, and spotted seals could be disturbed by spring or summer activities near the Nigliq Channel bridge. Denning polar bears could be disturbed—and mortality caused to cubs abandoned or introduced to the elements prematurely—by activities within about a mile of their dens if these dens are not detected and the disturbance avoided as required by regulation.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON MARINE MAMMALS

The Alternative A – FFD Scenario sites with the most potential to affect marine mammals are hypothetical pads HP-4, HP-5, HP-7, HP-8, HP-11, HP-12, HP-13, and HP-14 in the Colville River Delta; HP-1, HP-3, and HP-15 in the Fish-Judy Creeks Facility Group; and HP-21 and HP-22 in the Kalikpik-Kogru Rivers Facility Group.

COLVILLE RIVER DELTA FACILITY GROUP

Facilities in the river deltas have the potential to affect ringed seals, spotted seals, and beluga whales. Noise from construction of roads and facilities and aircraft traffic along the coast during the winter has the potential to disturb ringed seals. Construction and operations, and aircraft traffic during the summer, have the potential to displace spotted seals and beluga whales from river habitats. HP-5 is directly adjacent to the Nigliq Channel, andHP-4, HP-7, HP-8, HP-12, and HP-14 are adjacent to the main channel of the Colville River. Roads are planned to HP-4 and HP-5. Aircraft would serve the other pads.

Construction, operation, and aircraft and ground vehicle traffic have the potential to disturb denning and non-denning polar bears. Denning polar bears within approximately 1 mile of roads could be disturbed. Denning and non-denning polar bears could also be disturbed by aircraft traffic. Bears could also be displaced from, or drawn to, construction activities, depending on individual bears' reactions. Impacts to denning bears could result in abandonment or early emergence of cubs. Impacts to non-denning bears could range from displacement to death if a bear threatens human life or property, is struck by a vehicle, or encounters a toxic substance. Mitigation measures already in place for other arctic developments would minimize these impacts. Increased hunter access may result in more mortality of polar bears and seals.

FISH-JUDY CREEKS FACILITY GROUP

HP-3 and HP-15 lie within the delta of Fish and Judy creeks, and roads would access them. Local hunters from Nuiqsut identified Fish and Judy creeks as spotted seal and beluga habitat. Construction and operations activities and aircraft traffic to and from these sites may displace some spotted seals and beluga whales. The number of seals and whales affected would depend on the numbers that are present in the area. Disturbance would generally be short-term. Impacts to polar bears in this area would be similar to those described above for the Colville River Delta Facility Group. Disturbance of polar bears (including dens) is less likely the farther inland the sites would be.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

HP-21 and HP-22 are adjacent to the Kogru River, which is also potential spotted seal and beluga whale habitat. Construction and operation activities and aircraft traffic to and from the sites may disturb some spotted seals and beluga whales. Disturbance would generally be short-term. Impacts to polar bears would be similar to those described above for the Colville River Delta Facility Group. Disturbance of polar bears is less likely the farther inland the sites are.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON MARINE MAMMALS

There would be limited impacts on marine mammals from the CPAI Development Plan because the project is onshore. Construction of, and traffic on, a bridge over the Nigliq Channel and other rivers could cause some disturbance of spotted seals and beluga whales. Aircraft traffic to and from the Plan Area could also disturb some marine mammals. Construction and operational noise in winter could disturb some denning polar bears.

Access by local residents could increase harvest of marine mammals, including seals in the rivers and nearshore Beaufort Sea. Hunting by local residents on the oilfield roads could increase the mortality of polar bears that are onshore. Mortality of polar bears directly caused by the Alternative A development could include occasional road kills and killing of bears in DLP.

All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative effect at the population level. The experience in existing North Slope oilfields shows that populations of marine mammals have not been affected by onshore development. The inclusion of local access to, and possibly hunting in, the Alternative A development may cause disturbance and mortality that affect marine mammal populations. However, the past harvest levels of seals and polar bears by the local community are a small enough proportion of the populations that negative impacts are unlikely if proper mitigation and regulations are enforced. In fact, harvest is a primary tool of wildlife managers, for example, to keep a population at a level compatible with available habitat. A positive aspect of increased hunter access is that it could allow more control over hunting harvest if managers would have more ability to increase harvest when necessary. However, the local residents typically choose not to hunt around developed areas.

Impacts from Alternative A FFD would have the same effects described for the CPAI Development Plan but over a larger area.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR MARINE MAMMALS

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

1. Aircraft minimum altitude restrictions over the nearshore Beaufort Sea to reduce disturbance.

2. Surveys for polar bear dens prior to construction of ice roads or permanent roads and facilities would allow avoidance of the dens by 1 mile.

3. For Alternatives A and C, communications among stakeholders with activities in the Plan Area (including hunting by local residents) could help minimize conflicts.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR MARINE MAMMALS

The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulation 55 requiring aircraft to maintain a 1,000-foot AGL (except for takeoffs and landings) may reduce any disturbance of spotted seals hauled out along the Colville River Delta or ringed or bearded seals hauled out on the fast-ice along the coast. Stipulations 76 and 77 will reduce impacts to polar bears by minimizing bear/human interaction. Additional mitigation identified in this EIS would call for polar bear surveys that would allow for greater avoidance of den sites.

4A.3.5 Threatened and Endangered Species

4A.3.5.1 Bowhead Whale

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON BOWHEAD WHALES

Bowhead whales are not found in the Plan Area. During spring migration, bowheads are far offshore in the lead system of the Beaufort Sea. During fall migration, most bowheads pass north of a line from Cape Halkett to Oliktok Point. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, see Section 4.3. Alternative A construction and operations will not affect the bowhead whale population, habitat, migration, foraging, breeding, survival and mortality, or critical habitat.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON BOWHEAD WHALES

The only impacts to bowheads under FFD could be from aircraft noise and ships used to transport equipment through the Beaufort Sea to the Plan Area. In this case, bowheads could be affected by noise, fuel spills, and vessel strikes. However, the use of docks was determined not to be a practical means of developing the facilities proposed by CPAI or during future development, so the probability of vessel traffic would be low. If shipments in support of the ASDP are made to the existing West Dock, they can be timed for periods when bowheads are absent.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON BOWHEAD WHALES

Bowhead whales generally do not occur in the nearshore Beaufort Sea north of the Plan Area. During spring and fall migrations, bowheads are far offshore in the lead system of the Beaufort Sea. Activities that would occur in the Plan Area under all CPAI alternatives would not affect the bowhead whale population, habitat, migration, foraging, breeding, survival and mortality, or critical habitat.

In general, impacts from the Alternative A – FFD Scenario would be the same as those described for the CPAI Development Plan over a larger area. Under the FFD, sealifts may be used to transport drilling or processing facilities. In this case, there is the potential for additional impacts to bowhead whales from vessels. Impacts to bowheads could result from noise, pollution, and vessel strikes. However, the use of docks was determined not to be a practical means of developing the facilities proposed by CPAI or during future development, so this impact may not be realized. If some whales do come into the nearshore environment, there could be some disturbance of bowheads from air traffic over the Beaufort Sea. However, altitude restrictions would minimize these impacts.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR BOWHEAD WHALES

In the event of sealifts to transport material to the FFD sites, measures to minimize disturbance of, or strikes to, migrating whales by vessels are appropriate and would require coordination with NOAA Fisheries for compliance with the MMPA. Flight altitude restrictions in the nearshore environment would minimize disturbance from air traffic.

4A.3.5.2 Spectacled Eider

Impacts to spectalced eiders associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The operation period includes continued drilling and day-to-day operations and maintenance once production has begun. Site specific nest densities for spectacled eiders presented in Table 3.3.5-1 were used to estimate the number of nest exposed to each alternative. Gravel footprint acreage and habitat alteration acreage (Tables 4A.3.1-1, 4A.3.1-2, 4A.3.1-3, 4A.3.1-4, 4B.3.1-1, 4B.3.1-2, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-1, 4C-1.3.1-2, 4C-1.3.1-3, 4C-1.3.1-4, 4C-2.3.1-1, 4C-2.3.1-2, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, 4F.3.1-2) were multiplied by average nest densities (Table 3.3.5-1) to estimate the total number of spectacled eider nests potentially affected by habitat loss and alteration. In addition, spectacled eider nests disturbed by air traffic were estimated using a maximum of a 67 % reduction in nests within a 500-meter buffer around each airstrip or helipad. This %age was derived from review of Figures 15-17 for greater white-fronted geese in Johnson et al. (2003a). No additional loss due to disturbance from vehicle traffic was calculated because losses within 50 meters of roads were considered sufficient to account for disturbance as well as habitat alteration impacts. Habitat loss due to ice roads was estimated using the average number of acres per year covered by ice roads during construction and operations (Tables 2.4.1-2; 2.4.1-9; 2.4.2-2; 2.4.2-8; 2.4.3-4; 2.4.3-10; 2.4.4-2; 2.4.4-6; and 2.4.4-10). Results of these analyses are presented in Tables 4A.3.5-1 and 4A.3.5-4. Preferred nesting and brood-rearing habitats (see Section 3.3.5.2 and Table 3.3.5-1) were also considered in evaluating impacts for spectacled eiders. Oil spills also may directly or indirectly affect spectacled eiders in the Plan Area. Impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SPECTACLED EIDER

This section describes the potential impacts of the ASDP on threatened spectacled eiders. Impacts to other bird groups associated with the proposed development are described in Section 4A.3.3 and can be referred to for more detailed description of specific impacts. In Alternative A, the access road to CD-6 and CD-6 are within the sensitive 3-mile Fish Creek buffer and power lines are placed on poles between CD-6 and CD-7. These aspects of Alternative A do not conform with protective stipulations specified for development within the Northeast National Petroleum Reserve-Alaska Planning Area.

Spectacled eiders in the Colville River Delta are associated with coastal areas averaging about 4.0 km from the coast and within 14.3 km of the coast. Of the proposed pad sites, CD-3 has the highest concentration of spectacled eiders and is the area where impacts to spectacled eiders are likely to be greatest (see Table 3.3.5-1). The outer Colville River Delta has an average density of 0.21 spectacled eiders/km^2 during pre-nesting (n = 9 years) (Johnson et al. 2003b). Spectacled eiders are less common in the CD-4 area (less than 0.01 birds/km^2 during pre-nesting) than in the CD-3 area (Burgess et al. 2003a, Johnson et al. 2003b). The potential impacts of development at CD-4 would likely affect fewer spectacled eiders than would be affected at the CD-3 site. Spectacled eiders are also less common in the general area of the sites proposed for development in the eastern National Petroleum Reserve-Alaska compared to the northern portion of the Colville River Delta (Burgess et al. 2003b). The density of spectacled eiders during pre-nesting in the National Petroleum Reserve-Alaska portion of the Plan Area has ranged from 0.02 to 0.09 birds/km^2 (Anderson and Johnson 1999, Murphy and Stickney 2000, Burgess et al. 2003b).

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter placement of gravel and mining during construction would account for most of the direct habitat lost or altered by the proposed development. Tundra covered by gravel would be unavailable for spectacled eider nesting, brood-rearing, and foraging habitat. A summary of habitats lost due to gravel fill and altered by dust outfall, gravel spray, snow drifting, thermal and moisture regime changes by CPAI Development Plan Alternatives in the Colville River Delta and the National Petroleum Reserve-Alaska with habitat use by spectacled eiders is presented in Table 4A.3.5-2 and Table 4A.3.5-3. An estimated 0.7 spectacled eider nests would potentially be affected by habitat loss and alteration due to gravel fill based on nesting densities in the CD-3 area and in the National Petroleum Reserve-Alaska (Table 4A.3.5-1). In all cases, less than 1 % of habitats preferred or used by pre-nesting, nesting or brood-rearing spectacled eiders in the Colville River Delta and the National Petroleum Reserve-Alaska portion of the Plan Area would be directly and indirectly affected by gravel fill (Table 4A.3.5-2 and Table 4A.3.5-3).

Dust deposition can affect eider habitat by causing early green-up on tundra adjacent to roads and pads that could attract spectacled eiders and other waterfowl early in the season when other areas are not yet snow-free. Dust deposition can also increase thermokarst and soil pH and reduce the photosynthetic capabilities of plants in areas adjacent to roads (Walker and Everett 1987, Auerbach et al. 1997). Traffic levels, air traffic (including helicopters), and wind can all influence the amount of dust that is deposited adjacent to roads and pads.

Nesting habitat loss associated with gravel placement would occur on tundra adjacent to gravel structures where accumulated snow from snow plowing activities or snowdrifts becomes compacted and causes delayed snowmelt. Delayed snowmelt that persists into the nesting season would preclude eiders from nesting in these areas. Delayed melt resulting from the construction and use of ice roads during winter activities would also cause habitat loss. The maximum area covered by ice roads in a single year would be 393 acres, with an average of 210 acres per year. An estimated 0.1 spectacled eider nest would potentially be affected by ice road construction based on the average of 210 acres per year (Table 4A.3.5-1). Ice roads would be expected to cover habitats similar to gravel placement in the project area and would not be expected to affect a significant proportion of the available preferred or used pre-nesting, nesting, or brood-rearing habitats within the Colville River Delta or within the National Petroleum Reserve-Alaska portion of the Plan Area (Table 4A.3.5-2 and Table 4A.3.5-3).

Ponding created by gravel structures, ice roads, or snowdrifts could become permanent water bodies that persist from year to year or they might be ephemeral and dry up early during the summer (Walker et al. 1987, Walker 1996). Ponding could create new feeding and brood-rearing habitat that might be used by some bird species (Kertell 1993, 1994). Impoundments that drain during incubation can lead to decreased productivity for nests that end up far from the water's edges (Kertell 1993, 1994). Placement and maintenance of culverts in roadways eliminates or mitigates the formation of ponding. The Clover Potential Gravel Source would add aquatic habitat after reclamation that might be suitable for use by waterfowl (Appendix O).

TABLE 4A.3.5-1 CPAI ALTERNATIVES A-F – ESTIMATED NUMBERS OF SPECTACLED EIDER NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Spectacled Eider	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
CPAI Alternative A	0.1	0.2	0.0	0.9	1.2	0.1	0.3	0.1	0.0	0.5	1.7
CPAI Alternative B	0.1	0.2	0.0	0.9	1.2	0.1	0.2	0.1	0.3	0.7	1.9
CPAI Sub-Alternative C-1	0.1	0.1	0.0	0.0	0.2	0.1	0.5	0.1	0.0	0.7	0.9
CPAI Sub-Alternative C-2	0.1	0.1	0.0	0.0	0.2	0.1	0.5	0.1	0.0	0.7	0.9
CPAI Sub-Alternative D-1	0.1	0.2	0.0	1.1	1.4	0.1	0.1	0.1	0.3	0.6	2.0
CPAI Sub-Alternative D-2	0.0	0.1	0.0	0.5	0.6	0.0	0.0	0.0	0.1	0.1	0.7
CPAI Alternative F	0.1	0.2	0.0	0.9	1.2	0.1	0.3	0.1	0.0	0.5	1.7

Notes:
[a] See Section 4A.3.5.2 for assumptions and calculation methods

TABLE 4A.3.5-2 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE COLVILLE RIVER DELTA BY SPECTACLED EIDERS

Habitat Type	Colville River Delta[a]											Spectacled Eider[b]		
	Acres in Colville River Delta[b]	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Alternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting	Brood-Rearing
Open Nearshore Water	1,162													
Brackish Water	1,807											P		
Tapped Lake with Low-water Connection	5,397					3.0	<0.1%	<0.1	<0.1%					
Tapped Lake with High-water Connection	5,146	1.0	<0.1%	1.0	<0.1%	1.2	<0.1%	0.6	<0.1%	1.0	<0.1%			
Salt Marsh*	4,473	0.5	<0.1%	0.5	<0.1%	15.6	0.3%	0.8	<0.1%	0.5	<0.1%	P		
Tidal Fla*t	18,187											A		
Salt-killed Tundra*	6,362											P		U
Deep Open Water without Islands*	5,650	1.3	<0.1%	1.3	<0.1%	3.2	<0.1%	1.2	<0.1%	0.1	<0.1%			U
Deep Open Water with Islands or Polygonized Margin*	2,160	8.1	0.4%	8.0	0.4%	13.8	0.6%	0.1	<0.1%	0.2	<0.1%	P		U
Shallow Open Water without Islands	547	1.7	0.3%			0.3	<0.1%	0.1	<0.1%	1.7	0.3%			
Shallow Open Water with Island or Polygonized Margins	155			<0.1	<0.1%							P		
River or Stream	20,306	7.7	<0.1%	2.5	<0.1%	17.6	<0.1%	3.9	<0.1%	7.7	<0.1%	A		
Aquatic Sedge Marsh	32													
Aquatic Sedge with Deep Polygons	3,275	15.3	0.5%	15.3	0.5%	8.0	0.2%	15.3	0.5%	15.3	0.5%	P	U	U
Aquatic Grass Marsh*	369	1.6	0.4%	1.6	0.4%	1.6	0.4%			2.5	0.7%			
Young Basin Wetland Comple*x	0													
Old Basin Wetland Complex*	2													
Riverine Complex*	0													
Dune Complex	0													
Nonpatterned Wet Meadow	11,162	60.5	0.5%	36.0	0.3%	47.3	0.4%	49.3	0.4%	68.6	0.6%		U	
Patterned Wet Meadow	27,969	150.3	0.5%	125.5	0.4%	381.3	1.4%	214.8	0.8%	161.1	0.6%	A	U	U
Moist Sedge-Shrub Meadow	2,927	69.8	2.4%	69.8	2.4%	94.7	3.2%	5.7	0.2%	70.4	2.4%	A		
Moist Tussock Tundra	525	1.1	0.2%			0.1	<0.1%			1.1	0.2%			
Riverine Low and Tall Shrub*	1,270	1.2	<0.1%			5.5	0.4%			1.2	<0.1%			

TABLE 4A.3.5-2 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE COLVILLE RIVER DELTA BY SPECTACLED EIDERS (CONT'D)

Habitat Type	Colville River Delta[a]													
	Acres in Colville River Delta[b]	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration [c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Alternative F Loss or Alteration[c] (Acres and %)		Spectacled Eider[b]		
												Pre-Nesting	Nesting	Brood-Rearing
Upland Low and Tall Shrub	419					0.1	<0.1%							
Upland and Riverine Dwarf Shrub*	0													
Riverine or Upland Shrub	6,305	32.9	0.5%	24.4	0.4	66.6	1.1%	18.3	0.3%	32.9	0.5%	A		
Barrens (riverine, eolian, or lacustrine)	20,993	17.3	<0.1%	9.9	<0.1%	17.5	<0.1%	3.6	<0.1%	17.3	<0.1%	A		
Artificial (water, fill, peat road)	38													
Total Area	146,638	370.4	0.3%	295.8	0.2%	677.6	0.5%	313.6	0.2%	381.5	0.3%			

Notes:

[a] Totals from Tables 4A.3.1-2, 4B.3.1-2, 4C1.3.1-2, 4D.3.1-2, 4F.3.1-2.

[b] Selection (A, P) or use (U, ≥10% of observations) of habitats by life history stage (Johnson et al. 2003b, 2004).

[c] Total includes gravel for pads, roads, and airstrips indirectly affected by gravel fill.

* key Wetlands

TABLE 4A.3.5-3 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE NATIONAL PETROLEUM RESERVE-ALASKA BY SPECTACLED EIDERS

Habitat Type	National Petroleum Reserve-Alaska Areaa											Spectacled Eider[b]	
	Acres in NPR-A	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Aternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting
Open Nearshore Water	0												
Brackish Water	2												
Tapped Lake with Low-water Connection	412												
Tapped Lake with High-water Connection	7												
Salt Marsh*	36											P	
Tidal Flat*	0												
Salt-killed Tundra*	0												
Deep Open Water without Islands*	12,386	0.9	0.1%	<0.1	0.1%	0.4	<0.1%			0.5	<0.1%		
Deep Open Water with Islands or Polygonized Margins*	9,988	0.3	<0.1%	<0.1	<0.1%					0.1	<0.1%		U
Shallow Open Water without Islands	1,744	0.2	<0.1%	1.8	<0.1%	0.3	<0.1%			0.4	<0.1%		
Shallow Open Water with Island or Polygonized Margins	2,877	2.3	0.1%	1.6	<0.1%	2.6	<0.1%			3.0	<0.1%	P	U

TABLE 4A.3.5-3 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE NATIONAL PETROLEUM RESERVE-ALASKA BY SPECTACLED EIDERS (CONT'D)

Habitat Type	National Petroleum Reserve-Alaska Areaa											Spectacled Eider[b]	
	Acres in NPR-A	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Aternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting
River or Stream	1,456	0.7	<0.1%			0.4	<0.1%			0.7	<0.1%		
Aquatic Sedge Marsh	3,037	7.6	0.3%	3.2	0.1%	6.6	0.2%	1.4	<0.1%	6.3	0.2%		
Aquatic Sedge with Deep Polygons	66												
Aquatic Grass Marsh*	501												
Young Basin Wetland Complex*	624	19.1	3.1%	19.1	3.1%	19.1	3.1%	23.5	3.7%	20.3	3.6%		
Old Basin Wetland Complex*	15,673	42.9	0.3%	30.2	0.2%	64.4	0.4%	7.6	<0.1%	43.9	0.3%	P	U
Riverine Complex*	698	4.1	0.6%			2.7	0.4%			4.0	0.6%		
Dune Complex	1,889												
Nonpatterned Wet Meadow	5,697	24.5	0.4%	29.0	0.5%	24.1	0.4%	22.4	0.4%	29.1	0.5%		
Patterned Wet Meadow	19,861	105.1	0.5%	23.6	0.1%	81.1	0.4%	26.4	0.1%	105.8	0.5%		U
Moist Sedge-Shrub Meadow	42,071	232.1	0.6%	168.9	0.4%	389.5	0.9%	50.8	0.1%	303.1	0.7%		
Moist Tussock Tundra	49,647	581.3	1.2%	267.7	0.5%	795.5	1.6%	233.1	0.5%	565.7	1.1%	A	
Riverine Low and Tall Shrub*	1,803	1.9	0.1%	<0.1	<0.1%	1.2	<0.1%			1.9	0.1%		
Upland Low and Tall Shrub	735					0.6	<0.1%						
Upland and Riverine Dwarf Shrub*	2,240			<0.1	<0.1%	3.3	0.1%	0.8	<0.1%				
Riverine or Upland Shrub	0												
Barrens (riverine, eolian, or lacustrine)	1,552												
Artificial (water, fill, peat road)	150					0.4	0.3%						
Total Area	**175,152**	**1023.3**	**0.6%**	**545.3**	**0.3%**	**1392.2**	**0.8%**	**366.0**	**0.2%**	**1084.6**	**0.6%**		

Notes:
[a] Totals from Tables 4A.3.1-2, 4B.3.1-2, 4C1.3.1-2, 4D.3.1-2, 4F.3.1-2.
[b] Selection (A, P) or use (U, ≥10% of observations) of habitats by life history stage (Burgess et al. 2003b, Johnson et al. 2004).
[c] Total includes gravel for pads, roads, and airstrips indirectly affected by gravel fill.
* Key Wetlands

Spectacled eider nests average less than 4 meters from lake shorelines in the CD-3 area (Johnson et al. 2003a), and water withdrawal from lakes during ice road construction could lower the level of lakes and influence spectacled eider nesting habitat. Changes in the surface levels of lakes from water withdrawals depend on the amount of water withdrawn, the size of the lake, and the recharge rate. Water withdraw for construction of ice roads is not expected to alter spectacled eider pre-nesting, nesting, brood-rearing, or staging habitat because snowmelt recharge in early spring will increase and/or maintain water levels with adherence to State of Alaska volume withdraw permitting restrictions (Rovansek et al. 1996, Burgess et al. 2003b, Baker 2002).

Disturbance and Displacement

Because gravel placement would be conducted during the winter when spectacled eiders do not occur on the Arctic Coastal Plain, no spectacled eider nests would be disturbed or displaced by this activity. Some spectacled eiders would be disturbed during the summer breeding season by vehicle, aircraft, and boat traffic; noise from equipment on roads; noise from facilities; and pedestrian traffic. Disturbance by vehicles, equipment activities such as road grading and compaction, or aircraft during summer would decrease the numbers of spectacled eiders nesting, brood-rearing, or foraging adjacent to roadways (Ward and Stehn 1989, Murphy and Anderson 1993, Johnson et al. 2003b).

Noise and visual stimuli associated with helicopter and fixed-wing air traffic would disturb spectacled eiders near the proposed airstrip at the CD-3 site. Responses of birds to aircraft include alert postures, interruption of foraging behavior, and flight. Such disturbances may displace birds from nesting, brood-rearing and feeding habitats and negatively impact energy budgets. The potential for noise associated with aircraft to have negative impacts on birds is probably greatest during the nesting period when movements of incubating birds are restricted. The highest aircraft noise levels occur during takeoff as engines reach maximum power levels. During landings, aircraft noise levels are reduced as engine power decreases. Studies at Alpine Field indicate that disturbance during heavy construction would result in displacement of 0 to 67 % of nesting greater white-fronted geese within 500 meters of the airstrip (Johnson et al. 2003b). On the basis of spectacled eider nesting density in the CD-3 area, a similar response to disturbance would result in an estimated displacement of 0.9 spectacled eider nest.

Anderson et al. (1992) reported that during the nesting period, spectacled eiders near the GHX-1 facility in the Prudhoe Bay area appeared to adjust their use of the area to locations farther from the facility in response to noise. Spectacled eiders nesting near the proposed airstrip at the CD-3 site might be similarly affected and might relocate nest sites to areas farther from the airstrip in response to noise and movements from vehicular traffic and machinery and from air traffic.

Obstructions to Movement

In general, the infrastructure associated with Alternative A, including roads and production pads, the airstrip, buildings, elevated pipelines, and bridges, would not be major obstructions to movements of spectacled eiders. These birds can fly and can easily move over or around these structures. These structures may present some obstructions during brood-rearing and molting periods when birds are flightless, particularly if traffic levels are high (Murphy and Anderson 1993). However, Troy Ecological Research Associates (TERA) (1996) reported that spectacled eider broods did not avoid facilities, crossed roads, and were found in or moved to high noise areas such as gathering centers and the Deadhorse airport.

Mortality

Other than potential oil spill-related mortality (see Section 4.3), there likely would be little spectacled eider mortality related to the development under Alternative A. Some spectacled eider mortality would result from collisions with vehicular traffic, although roads in Alternative A are located in areas with very low spectacled eider density. Reduced speed limits along roads, particularly during periods of poor visibility, may help to reduce the potential for bird collisions with vehicles. Some mortality of a few individuals would be associated with birds that collide with structures such as power lines, pipelines, buildings, or bridges, although collisions would be infrequent (Murphy and Anderson 1993). Mortality of a few individuals would be associated with collisions with aircraft during takeoff or landing. Collisions with aircraft are the most likely source of mortality with the location of the airstrip at CD-3, in an area with the highest nesting density of spectacled eiders in the Project Area. Effects of mortality from aircraft collisions could be mitigated by hazing of birds away from active airstrips.

Some predators, such as ravens, glaucous gulls, arctic foxes, and bears, may be attracted to areas of human activity where they find human-created (anthropogenic) sources of food and denning or nesting sites (Larson 1960, Eberhardt et al. 1982, Day 1998, Burgess 2000, USFWS 2003b). The availability of anthropogenic food sources, particularly during the winter, may increase winter survival of arctic foxes and contribute to increases in the arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Increased levels of depredation resulting from elevated numbers of predators could adversely affect nesting and brood-rearing success for waterfowl and loons. Arctic foxes, glaucous gulls, bears, and common ravens prey on eggs and young of waterfowl and loons (Murphy and Anderson 1993, Noel et al. 2002b, Rodrigues 2002, Johnson et al. 2003a, USFWS 2003b). The NRC in their review of the cumulative effects of oilfield development on the North Slope (NRC 2003) concluded that ". . . high predation rates have reduced the reproductive success of some bird species in industrial areas to the extent that, at least in some years, reproduction is insufficient to balance mortality." The NRC (2003) review focused on the Prudhoe Bay Oilfield with most studies conducted through the mid-1990s when the landfill and dumpsters were accessible by gulls, ravens, bears and foxes. Since the late 1990s the landfill has been fenced to exclude bears and animal proof dumpsters have been installed throughout North Slope oilfields. At a more recent workshop on human influences on predators of ground-nesting birds on the North Slope, sponsored by the USFWS, participants concluded that common ravens have increased in response to developments, but that increases in arctic fox, bear and glaucous gull populations were uncertain (USFWS 2003b). There was further uncertainty in the link between increased predator populations and resulting population level impacts to ground-nesting birds.

The numbers of foxes and most avian predators in the Alpine Development Project area did not appear to increase during construction of the project, with the exception of common ravens, which nested on buildings at the Alpine Development Project site (Johnson et al. 2003a). There was no indication that the presence of this pair of ravens caused an increased in nest depredation within 2 miles of APF-1 (Johnson et al. 2003a). There is evidence, however, that common ravens nesting at Alpine, Nuiqsut, and Meltwater, based on their flight paths, reduced nesting success as much as 14 to 26 miles away at the Anachlik Colony (Helmericks 2004, J. Helmericks 2004, pers. comm.). Productivity for red-throated loons was reduced by over 70 % from averages of 85 to 90 % from 1987 to 2002, and to 12 % in 2003 primarily attributable to the increase in ravens observed foraging at the colony (Helmericks 2004, J. Helmericks 2004, pers. comm.). Common ravens also learned to raid nest boxes designed for long-tailed ducks and northern pintail ducks, destroying 13 of 24 nests in shelters in 2003; and 8 of 10 nests outside of shelters (J. Helmericks 2004, pers. comm., Helmericks 2004). Predator observations throughout the Plan Area documented jaegers and glaucous gulls as the most common nest predators followed by common ravens (Johnson et al. 2004).

Installation of predator-proof dumpsters at camps and improved refuse handling techniques minimize the attraction of predators to landfills. Oilfield workers undergo training to make them aware of the problems associated with feeding wildlife. These practices minimize the potential impacts related to increased levels of depredation and would be continued in the ongoing development of the Alpine Development Project. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

Researchers conducting studies on avian nest density and success may inadvertently affect nesting success by attracting predators to nests and broods (Bart 1977, Götmark 1992, Strang 1980). Birds that are flushed from their nests during surveys are more susceptible to nest depredation than are undisturbed birds. Ongoing activities by researchers could cause some mortality to spectacled eider eggs and chicks. Care should be taken by researchers to minimize research-related impacts that may occur, particularly from activities that flush incubating eiders from nests.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Spectacled eider habitat loss and alteration from snowdrifts, gravel spray, dust fallout, and alteration of thermal and moisture regimes would continue during project operation. Additional post-construction habitat alterations would include ice roads and compaction by low-ground-pressure vehicles during summer or winter. These changes would affect an unknown number of additional spectacled eider nests.

Disturbance and Displacement

Disturbance and displacement from aircraft and vehicle traffic and facility noise would be similar to the construction phase. Disturbance would be reduced from the construction phase because of reduced levels of both air and ground traffic. Disturbance types along with the general reactions of spectacled eiders are discussed under the construction period.

Boat traffic during oil spill drills, equipment checks, and boom deployment, especially airboat traffic, could be disruptive to pre-nesting, nesting, foraging, and brood-rearing spectacled eiders. Spectacled eiders did not appear to use riverine habitats during pre-nesting, nesting or brood-rearing in either the Colville River Delta or the National Petroleum Reserve-Alaska sites proposed for development. Based on observations from the 1980s to 2003 (Helmericks 2004), eiders may have already been displaced from some riverine habitats in the Colville River Delta by boat activity associated with eider harvests and spring waterfowl hunting.

Obstructions to Movement

Obstructions to movements from roadways would continue during project operations and would be similar to project construction. Obstructions would be reduced from construction because of reduced traffic levels.

Mortality

Some spectacled eider mortality would result from collisions with aircraft, vehicles, elevated pipelines, buildings, power lines, or bridges, particularly under poor visibility conditions. Collisions would be limited to a few individuals and frequency of vehicle collisions would be reduced during operations compared to during construction because of reduced traffic levels. Road access from Nuiqsut would allow for increased local traffic and access to the lower delta and marine waters of Harrison Bay which could result in increased subsistence hunting pressure and increased spectacled eider mortality.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Power lines placed on poles from CD-6 to CD-7 would benefit avian predators by providing perches. Nest and duckling depredation due to predators attracted to developments could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SPECTACLED EIDER

Under the Alternative A scenario for FFD, the mechanisms associated with impacts related to habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups would be the same as those described under Alternative A for the ASDP. Under Alternative A FFD, roads would link all production pads, except for four pads in the lower Colville River Delta and one pad in the Kalikpik-Kogru Rivers area (HP-22), to processing facilities and to the existing Alpine Development Project facilities. Airstrips would be constructed at production pads in the lower Colville River Delta and the Kalikpik-Kogru Rivers areas for maintenance and operational support. Development in the three areas would be in addition to the development proposed under Alternative A of the ASDP, and the potential impacts described below would be in addition to those described under Alternative A for the ASDP. The effects of FFD on spectacled eiders would depend on the location and extent of development within each area. Table 4A.3.5-4 presents a summary of the estimated numbers of spectacled eider nests potentially affected by the hypothetical FFD in Alternative A based on ground-based nest densities in the Colville River Delta and in the National Petroleum Reserve-Alaska portion of the Plan Area (Table 4A.3.5-1) proposed for development in CPAI Alternatives.

TABLE 4A.3.5-4 ALTERNATIVES A-D FFD SCENARIOS – ESTIMATED NUMBERS OF SPECTACLED EIDER NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Spectacled Eider	Habitat Loss	Habitat Alteration	Ice road Habitat Loss	Air Traffic Disturbanc e	Total[a]
Alternative A - FFD Scenario					
Colville River Delta Group	0.6	1.7	0.3	4.0	6.6
Fish-Judy Creek Group	0.4	1.4	0.0	0.2	2.0
Kalikpik-Kogru Group	0.1	0.6	0.1	0.3	1.1
Alternative A - FFD Scenario Totals	**1.1**	**3.7**	**0.4**	**4.5**	**9.7**
Alternative B - FFD Scenario					
Colville River Delta Group	0.6	1.7	0.3	4.0	6.6
Fish-Judy Creek Group	0.3	1.0	0.1	0.5	1.9
Kalikpik-Kogru Group	0.1	0.5	0.1	0.2	0.9
Alternative B - FFD Scenario Totals	**1.0**	**3.2**	**0.5**	**4.7**	**9.4**
Alternative C - FFD Scenario					
Colville River Delta Group	0.6	2.9	0.3	0.0	3.8
Fish-Judy Creek Group	0.4	1.4	0.1	0.2	2.1
Kalikpik-Kogru Group	0.1	0.7	0.1	0.2	1.1
Alternative C - FFD Totals	**1.1**	**5.0**	**0.5**	**0.4**	**7.0**
Sub-Alternative D-1 - FFD Scenario					
Colville River Delta Group	0.7	1.3	1.0	6.0	9.0
Fish-Judy Creek Group	0.3	0.4	0.3	2.0	3.0
Kalikpik-Kogru Group	0.1	0.1	0.3	0.8	1.3
Sub-Alternative D-1 - FFD Scenario Totals	**1.1**	**1.8**	**1.6**	**8.8**	**13.3**
Sub-Alternative D-2 - FFD Scenario					
Colville River Delta Group	0.5	0.3	0.4	2.8	4.0
Fish-Judy Creek Group	0.1	0.1	0.1	0.7	1.0
Kalikpik-Kogru Group	0.1	0.0	0.1	0.3	0.5
Sub-Alternative D-2 - FFD Scenario Totals	**0.7**	**0.4**	**0.6**	**3.8**	**5.5**

Notes:
[a] See Section 4A.3.5.2 for assumptions and methods

COLVILLE RIVER DELTA FACILITY GROUP

Habitat Loss and Alteration

In addition to habitat loss described under Alternative A for the ASDP, there would be additional habitat loss at the Colville River Delta for airstrips associated with the hypothetical HP-7, HP-12, HP-13, and HP-14 sites. Short gravel roads would connect the CD-2 and CD-4 sites of the ASDP with HP-5 and HP-4, respectively. HP-8 would be connected by a road system to Nuiqsut and the existing Alpine Development Project.

Pre-nesting spectacled eiders are concentrated in the northwestern portion of the Delta north of the hypothetical HP-5 and HP-7 sites and west of the hypothetical HP-11 and HP-13 sites (Johnson et al. 1999). For the sites proposed under Alternative A FFD, the highest pre-nesting concentrations of spectacled eiders were reported in the vicinity of the HP-5 site (Johnson et al. 1999). An estimated 2.3 spectacled eider nests would be affected by habitat loss and alteration (Table 4A.3.5-4).

Disturbance and Displacement

Under Alternative A for FFD in the Colville River Delta Facility Group, aircraft traffic and noise likely would be the greatest source of disturbance to spectacled eiders. The types of disturbances would be the same as those described under Alternative A for the ASDP, but the potential impacts to spectacled eiders would be increased because of the increase in the number of airstrips.

Most displacement in Alternative A FFD would be from disturbance created by air traffic in the outer Colville River Delta. Based on a 67 % reduction in birds and nests within 500 meters of the airstrips, an estimated 4.0 spectacled eider nests would be displaced by air traffic disturbance (Table 4A.3.5-4).

Disturbance related to vehicular traffic and machinery would also affect eiders along the access roads to HP-4 and HP-5 as well as along the short access roads from production pads to airstrips at the other sites. The road from Nuiqsut may increase the potential for local traffic to affect spectacled eiders along the access roads to the CD-2, CD-3, CD-4, HP-4, and HP-5 sites. The types of disturbances would be the same as those described above under Alternative A for the ASDP sites. Disturbance to spectacled eiders from vehicular traffic and other associated road disturbances would be most likely to occur at the HP-5 site and the proposed access road to HP-5, where spectacled eider concentrations are higher. Disturbance in conjunction with habitat alteration within 50 meters of roads and pads would displace an estimated 1.7 spectacled eider nests (Table 4A.3.5-4).

Obstructions to Movements

Under Alternative A for FFD in the Colville River Delta Facility Group, there would be little increase in the potential for the proposed development to obstruct spectacled eider movements compared to Alternative A of the ASDP. Most of the proposed sites are roadless, and there is little evidence that pipelines present more than occasional, temporary obstruction to bird movements. Short access roads would be constructed for the HP-4 and HP-5 sites, although brood-rearing eiders may be delayed in crossing. High traffic levels or high speeds on roads could pose some obstruction to spectacled eider movements if birds were displaced because of disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, could help to minimize the potential for roads to obstruct bird movements.

Mortality

Bird mortality could result from collisions with vehicular traffic, buildings, pipelines, and bridges. Potential additional mortality from air strikes could result from the additional airstrips in the outer Colville River Delta. In Alternative A FFD, traffic levels in the Colville River Delta area would be minimal because of the roadless condition of most of the project.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality near the CD-2, CD-3, CD-4, HP-4, and HP-5 sites.

FISH-JUDY CREEKS FACILITY GROUP

Habitat Loss and Alteration

Habitat loss and alteration could occur in the Fish-Judy Creeks Facility Group from gravel placement for access roads and production pads. In the area of Fish and Judy creeks, the highest concentration of spectacled eiders was reported near the hypothetical HP-1 site and in portions of the area surrounding the hypothetical HP-15 site. Spectacled eider densities are generally lower in the Fish-Judy creek area than in the Colville River Delta area. Based on projected gravel fill for these hypothetical facilities, an estimated 1.8 spectacled eider nests would be displaced by habitat loss and alteration (Table 4A.3.5-4).

Disturbance and Displacement

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, vehicular traffic and other activities associated with the road system would be the greatest source of disturbance. In addition, noise associated with the hypothetical processing facility HPF-1 could also affect birds. The mechanisms of impacts would be the same as those described above under Alternative A for the ASDP sites. The greatest potential for vehicular traffic to affect spectacled eiders would occur along the proposed access road to HP-1 and possibly in the vicinity of HP-15. Displacement due to air traffic at HPF-1 would affect an additional estimated 0.2 spectacled eider nests (Table 4A.3.5-4).

Obstructions to Movements

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, potential obstruction to spectacled eider movements could occur along the road system particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if the roads are open to local traffic. In general, roads do not present obstructions to bird movements. High traffic levels or high speeds on roads could pose some obstruction to spectacled eider movements if birds were displaced due to disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to minimize potential for roads to obstruct eider movements.

Mortality

Mortality could result from collisions of spectacled eiders with vehicular traffic. The potential for eider mortality associated with vehicular collisions under Alternative A for the FFD would be increased compared to Alternative A for the ASDP because of the increased road system. Reduced speed limits along roads, particularly during periods of poor visibility, may help to reduce the potential for eider collisions with vehicles. Spectacled eider mortality could result from collisions with buildings, pipelines, and bridges. Potential additional mortality from air strikes could result from the airstrip at the HPF-1 within the three-mile Fish Creek buffer.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality near HP-1 and HP-3.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Habitat Loss and Alteration

Habitat loss and alteration would occur in the Kalikpik-Kogru Rivers Facility Group from gravel placement for access roads and production pads, although the concentrations of spectacled eiders reported for this area were generally lower than those reported for the Fish-Judy Creeks and Colville River Delta facility groups. The highest spectacled eider concentrations in the Kalikpik-Kogru Rivers Facility Group were reported in portions of the areas surrounding HP-20 and HPF-2. Based on projected gravel fill for these hypothetical facilities, an estimated 0.7 spectacled eider nests would be displaced by habitat loss and alteration.

Disturbance and Displacement

Under Alternative A for FFD in the Kalikpik-Kogru Rivers Facility Group area, vehicular traffic and other activities associated with the road system would be a source of disturbance to spectacled eiders. Road access from Nuiqsut could increase the potential for local traffic to disturb eiders along the entire road system of the Kalikpik-Kogru Rivers Facility Group area, particularly near HP-20 and HPF-2. In addition, noise associated HPF-2 would potentially affect eiders.

Placement of the airstrip for HP-22 and HPF-2 would increase disturbance to spectacled eiders due to noise from air traffic. Based on a 67 % reduction in birds or nests within 500 meters of the airstrip, an estimated 0.3 spectacled eider nest would be displaced by disturbance from air traffic.

Obstructions to Movements

Under Alternative A for FFD in the Kalikpik-Kogru Rivers Facility Group area, potential obstruction to spectacled eider movements would occur along the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if roads are open to local traffic.

Mortality

The potential for impacts of the FFD under Alternative A to affect spectacled eider mortality in the Kalikpik-Kogru Rivers Facility Group would be similar to that discussed above for the Fish-Judy Creeks Facility Group. The airstrip at HP-22 would increase the potential for mortality from collisions with aircraft. The potential impacts may be reduced compared to those for the Fish-Judy Creeks Facility Group area because of the reduced amount of infrastructure and lower densities of spectacled eiders in the Kalikpik-Kogru Rivers Facility Group area. Road access from Nuiqsut could increase the potential for subsistence hunting to affect spectacled eiders along the entire route of the road system in the Kalikpik-Kogru Rivers Facility Group area.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SPECTACLED EIDER

Impacts to spectacled eiders associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Spectacled eiders occur in greater numbers near proposed developments in the Colville River Delta than in the National Petroleum Reserve-Alaska portion of the Plan Area. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests affected by habitat loss, alteration and disturbance for each alternative, based on site specific nesting densities for spectacled eiders to compare alternative development scenarios. Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative A would reduce nesting by 4 % for Plan Area spectacled eiders. Alternative A – FFD Scenario would reduce nesting by 22 % for Plan Area spectacled eiders and less than 1 % for the North Slope population. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snow drifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The effects of these activities on estimated spectacled eider production due to loss, alteration or disturbance of nesting habitat for Alternative A, CPAI Development Plan is presented in Tables 4A.3.5-1 and 4A.3.5-4 for the FFD Scenario. Impacts from CPAI Alternatives A through F on habitats used by spectacled eiders are summarized in Table 4A.3.5-2 and Table 4A.3.5-3. Summaries of vegetation classes affected directly and indirectly by gravel fill for Alternative A – FFD Scenario are presented in Table 4A.3.5-4.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SPECTACLED EIDER

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the Alternative A – FFD Scenario. Mitigation measures protective of bird habitats are presented in Section 4A.3.4.

OBSTRUCTIONS TO MOVEMENTS

- Traffic speeds on roads would be reduced during brood-rearing.

MORTALITY

- Spectacled eiders would be hazed away from active airstrips to prevent collisions with aircraft.
- Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

4A.3.5.3 Steller's Eider

This section describes the potential impacts of the ASDP on threatened Steller's eiders. Impacts to other bird groups associated with the proposed development are described in Section 4A.3.3 and can be referred to for a more detailed description of the mechanisms of specific impacts. In general, impacts to Steller's eider potentially are the same as those described for the spectacled eider under all of the alternatives. However, the likelihood of impacts occurring to Steller's eider is very small, even under FFD scenarios, because they occur very rarely in the Plan Area. There would be a loss of potential Steller's eider habitat from the ASDP. Given the current distribution of Steller's eider in the Plan Area, it is unlikely that any of the project alternatives would affect this species.

4A.3.5.4 Abandonment and Rehabilitation Affecting Threatened and Endangered Species

Activities related to abandonment and rehabilitation in the Plan Area are not expected to affect bowhead whales. The impacts of abandonment and rehabilitation on spectacled and Steller's eiders would be similar in many respects to that incurred by construction activity.

Most impacts to spectacled eiders would be associated with activities near CD-3. Activities that occur in the winter would cause little disturbance or displacement, because eiders are absent from the area during the winter. However, ice roads could cause impoundments of water that could reduce habitat for nesting birds; such impacts would only affect nesting in the summer following ice road use. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to eiders similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips are not revegetated, they would remain lost habitat for eiders. If they are revegetated without removing the gravel, the habitat would not return to its current utility. If gravel is removed, habitat similar to that currently existing in the area could be created and used by eiders, though the precise mix of rehabilitated habitat types would likely not be the same as what currently prevails (Kidd et al. 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal. Fine particles of foam that may not be removed from the environment could be ingested by some birds incidentally; depending on the material's toxicity and the amount ingested, this could cause mortality, though the numbers are likely to be very small.

Table 4A.3.5-5 Alternative A – Summary of Affected Vegetation Classes for FFD Used by spectacled Eiders

Vegetation Classes	Colville River Delta Facilities Group[a]		Fish-Judy Creeks Facility Group[a]		Kalikpik-Kogru Facility Group[a]		Grand Total (acres)	Plan Area Totals[b]		Spectacled Eider Habitats
	Loss (acres)	Alteration (acres)	Loss (acres)	Alteration (acres)	Loss (acres)	Alteration (acres)		Acres	% Affected	
Riverine Complex	0.3	1.6	1.1	6.1	0.0	0.0	9.1	698.3	1%	
Fresh Grass Marsh	0.7	2.5	22.9	134.7	33.2	200.1	394.1	2583.7	15%	√
Fresh Sedge Marsh	<0.1	<0.1	17.8	52.9	11.7	18.1	100.7	40953.6	<1%	√
Deep Polygon Complex	4.4	9.9	18.8	33.7	11.8	18.3	96.9	55208.0	<1%	√
Young Basin Wetland Complex	0.9	5.4	55.5	303.5	19.4	92.1	476.8	22910.8	2%	
Old Basin Wetland Complex	1.5	9.3	25.9	136.0	0.0	0.0	172.7	15674.5	1%	√
Wet Sedge Meadow Tundra	91.9	266.6	135.3	657.3	76.6	232.4	1460.1	185820.8	1%	√
Salt-Killed Wet Meadow	12.4	25.3	0.0	0.0	0.0	0.0	37.7	6368.7	1%	√
Halophytic Sedge Wet Meadow	9.3	19.2	0.0	0.0	0.0	0.0	28.5	4453.2	1%	√
Halophytic Grass Wet Meadow	0.2	0.5	0.0	0.0	0.0	0.0	0.7	398.3	<1%	√
Moist Sedge-Shrub Tundra	13.2	56.5	81.8	424.7	0.0	0.0	576.2	44405.7	1%	
Tussock Tundra	7.9	43.2	186.8	886.0	151.6	726.1	2001.6	208178.9	1%	
Dryas Dwarf Shrub Tundra	0.2	0.5	2.3	10.0	0.0	0.0	13.0	1358.6	1%	
Cassiope Dwarf Shrub Tundra	4.9	29.5	128.6	774.2	15.4	83.5	1036.1	7734.0	13%	
Halophytic Willow Dwarf Shrub Tundra	0.1	0.1	0.0	0.0	0.0	0.0	0.2	143.1	<1%	√
Open and Closed Low Willow Shrub	20.5	65.3	14.5	79.7	4.2	25.3	209.5	13557.3	2%	
Open and Closed Tall Willow Shrub	<0.1	<0.1	1.8	8.1	0.0	0.0	10.1	687.2	1%	
Dune Complex	0.0	0.0	6.9	26.5	1.5	2.3	37.2	5913.9	1%	
Partially Vegetated	10.4	26.7	3.5	14.5	1.2	1.9	58.2	10149.3	1%	
Barrens	37.3	88.8	7.7	29.6	8.0	34.2	205.6	44009.2	<1%	
Totals	**215.9**	**650.9**	**711.1**	**3577.3**	**334.4**	**1434.1**	**6923.7**	**671207.1**	**1%**	

Notes:

[a] Totals from Tables 4A.3.1-3 and 4A.3.1-4

[b] Totals from Table 3.3.1-1 (no data, shadows and water categories not included)

Overall impacts of abandonment and rehabilitation on threatened and endangered species would be localized and no adverse impacts to North Slope populations are expected.

4A.3.5.5 Alternative A – Effectiveness of Protective Measures for Threatened and Endangered Species

Current management practices and stipulations developed through the permitting process and attached to land uses authorizations for temporary facilities, overland moves, seismic operations, and recreational operations, are adequate to protect endangered and threatened species. The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulation 55 requiring aircraft to maintain a 1,000-foot AGL (except for takeoffs and landings) may reduce disturbance of bowhead whales. Stipulations included under several categories, such as solid- and liquid-waste handling, hazardous-material disposal and cleanup, overland moves and seismic work, ground transportation, orientation program, aircraft traffic, and other activities should provide adequate protection to eiders from some activities. Additional mitigation measure identified in this EIS would include altitude restrictions to reduce aircraft impacts to bowhead whales, reducing speeds on roads, and hazing away from airports for eiders.

4A.4 SOCIAL SYSTEMS

4A.4.1 Socio-Cultural Characteristics

The socio-cultural characteristics of the North Slope communities of Nuiqsut, Barrow, Anaktuvuk Pass, and Atqasuk have been described in Section 3.4.1. These communities are small (Barrow is the largest with a population of 4,581) and primarily populated with Alaska Natives. These communities strive to maintain their traditional subsistence way of life but have adapted to and use a number of modern technologies. The communities are separated by relatively long distances and only one, Nuiqsut, is in close proximity to the Plan Area. Members of the other communities are known to interact with Nuiqsut and use portions of the Plan Area for subsistence activities.

4A.4.1.1 Alternative A – CPAI Development Plan Impacts on Socio-Cultural Characteristics

SOCIAL ORGANIZATION

As described in Section 3.4.1, the social organization of North Slope communities is based on kinship, marriage, and alliance groups formed by such characteristics as age, sex, ethnicity, community, and trade. Social organization is also based on the cultural values of the community, including sharing, mutual support, and cooperation.

Factors that are likely to cause stress or change to the social organization of the four communities include the following:

- Influx of non-Native residents not associated with an existing kinship group
- Influx of non-resident temporary workers
- Increased interaction between residents and oil industry workers
- Change in subsistence uses
- Reduction or disruption of harvest production
- Availability of new technologies (transportation, energy production, educational, etc.)
- Increased or variable personal and family annual income

Construction and operation of Alternative A – CPAI Development Plan is not expected to result in the significant influx of new, non-Native population. Oil industry construction and operations personnel will be housed in work camps or at centralized industry facilities co-located at industry production facilities. Because industry will provide worker housing, demand for housing in Nuiqsut is not expected to increase as a result of the proposed oil development.

The construction of winter ice roads near Nuiqsut and increased demand for accomodations at Nuiqsut could increase interaction between residents and oil industry workers. However, non-resident industry workers are not expected to seek leisure time activities or other services in Nuiqsut or the other communities to any significant degree. Industry practice is to have workers work 12-hour shifts for several weeks then be transported off the North Slope during their off days. Industry housing includes eating, exercise, and entertainment facilities so there would be no demand from industry workers for these services in Nuiqsut. In addition, the limited availability of ground transportation to industry workers is expected to minimize visits to Nuiqsut. No increase in visits by industry workers to Barrow, Atqasuk, or Anaktuvuk Pass is expected.

Disruption of subsistence harvest patterns and uses could affect community social organization. The sharing of subsistence foods is essential to the maintenance of family ties, kinship networks, and community well being. Disruption of subsistence-harvest patterns could alter these cultural values and affect community social structure. For the system of sharing to operate properly, some households must consistently produce a surplus of subsistence goods. For this reason, the supply of subsistence foods in the sharing network is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by primary producers. Thus, when disturbance to the subsistence harvest occurs, it could disrupt the community culture. Subsistence is a cyclical activity, and harvests vary from year to year, sometimes substantially. Numerous different species are hunted to compensate for a reduced harvest of a particular resource in any one year. However, multiyear disruptions to some important resources such as caribou or bowhead whale could have substantial effects on sharing networks and subsistence-task groups.

Subsistence harvest and use impacts under Alternative A – CPAI Development Plan are described in detail in Section 4A.4.3. This analysis found that threats to subsistence harvest success are likely as a result of the following factors:

- Displacement or deflection of subsistence resources from customary harvest locations

- Reduced access to customary harvest areas where oil industry facilities are located due to perceived restrictions on hunting techniques, especially the use of firearms, and hindrance to passage during winter along raised road berms and pipelines

- Preference for animals not habituated to industry facilities

As a result of these effects on traditional subsistence-use areas, especially those near Nuiqsut, subsistence hunters will likely travel farther and spend more time away from the community pursuing subsistence harvest activities. They also will have increased direct economic costs for subsistence resulting from increased fuel consumption, and maintenance and repair of equipment. This could increase a problem some North Slope residents perceive that cash employment takes hunters away from the community, which can lead to their missing short-term subsistence opportunities.

Effects on subsistence harvest and use, and any associated stress to community social organization, are most likely to occur in the community of Nuiqsut because of its proximity to the Plan Area. While community members of Barrow, Atqasuk, and Anaktuvuk Pass all pursue subsistence activities in the Plan Area, they take a larger proportion of their subsistence harvest from other areas not directly affected and thus are less likely to experience subsistence related disruption to their social organization.

Potential changes to the cultural organization of Nuiqsut could occur as a result of implementation of Alternative A – CPAI Development Plan. These changes, to the extent that they would occur, would most likely be related to increased stress in the community as a result of changes in the pattern and success of subsistence hunting. Changes to community social organization are not likely to occur as a result of the presence of additional industry workers in the region.

Community comment on Social Organization Impacts - North Slope Inupiat continue to express concern about the differences in how they and the dominant culture relate to the land and waters. Rex Okakok from Barrow expressed the problem when he stated:

> “Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat.” (USDOI, MMS 1987c)

ECONOMIC ORGANIZATION

As described in Section 3.4.1, the economic organization of Nuiqsut, Barrow, Anaktuvuk Pass, and Atqasuk is composed of a mixed cash and subsistence economy. Impacts to the subsistence economy (e.g., subsistence harvest and use) are described in Section 4A.4.3.

The cash economy of the potentially affected communities includes the wage income of community members, income derived by businesses owned by community members, and royalty and tax revenues and other distribution that flow to each community. Little increase in wage income is expected to occur under Alternative A – CPAI Development Plan. Increases in personal or family income resulting from increased Native corporation dividend distributions could occur.

As noted in the previous discussion of Social Organization, little increase in contact between non-resident industry workers and the local population, and, by inference, local businesses providing local services, is expected. Therefore, only a minimum increase in local business income would be expected. However, many of the contractors hired by the oil industry to support exploration, drilling, and production on the North Slope are Native corporations (ASRC et al.), subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures and other relationships. As previously noted, more than $250 million dollars in contract fees were received by the Kuukpik (Nuiqsut Village Corporation) during development of CD-1 and CD-2. To the extent that these companies are successful bidders for contracts during construction and operation, significant local economic benefits are expected to result from implementation of Alternative A – CPAI Development Plan.

INSTITUTIONAL / COMMUNITY SERVICES

Because oil industry workers (with the exception of current local residents) are not expected to seek housing in Nuiqsut or the other North Slope communities or seek to utilize education, health or other community services, no impact on the existing community institutions or services would be likely to occur. Current residents who do use these services are not expected to create an incremental increase in service demand as a result of industry employment should it occur.

COMMUNITY HEALTH AND WELFARE

Residents of North Slope communities, including the communities likely to be impacted by the proposed Alternative A – CPAI Development Plan, have documented increased rates of crime, drug abuse, domestic violence and child abuse, and other community welfare pathologies. While these health and welfare problems have increased over the time of oil industry development on the North Slope, they have not been directly linked to oil industry activity. Their occurrence is symptomatic of changes in community social organization, economy, and increased access to technology and sources of cash income. No direct impacts in rates of crime, drug abuse, domestic violence, child abuse, or other community welfare pathologies are expected to occur as a result of implementation of Alternative A. To the extent that changes in the subsistence harvest place stress on other elements of community structure, indirect impacts on community health and welfare could occur.

POPULATION AND EMPLOYMENT

Figure 3.4.1.7-1 shows trends in population growth for Nuiqsut, Barrow, and Atqasuk. Each community is expected to grow independent of the applicant's proposed action, although at modest rates. Indirect economic impacts under Alternative A – CPAI Development Plan could provide the impetus for some additional population growth in addition to the trend; however, the amount of this growth will likely be small.

Employment opportunities for local residents, especially Alaska Natives, as a result of Alternative A – CPAI Development Plan, could occur either as direct jobs for industry or as new jobs are created as a result of increased local economic activity (so-called "induced employment").

Employment of Alaska Natives in oil-related jobs on the North Slope has been low. In spite of this limited participation, community and NSB leaders continue to seek implementation of programs that would result in increased hiring of local residents, especially Alaska Natives. The NSB has attempted to facilitate Native employment in the oil industry at Prudhoe Bay and has expressed concern that industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural need to participate in subsistence hunting. The NSB also is concerned that even though recruitment efforts are made and training programs are available, industry recruits workers using methods more common to Western industry practices. Suggestions have been made that industry-hiring practices be modified to become more Inupiat-appropriate. One North Slope operator, BPXA, has instituted its Itqanaiyagvik hiring and training program, designed to put more Inupiat into the oilfield workforce. It is a joint venture with the ASRC and its oilfield subsidiaries and is coordinated with the NSB and the North Slope Borough School District. Other initiatives are an adult "job-shadowing" program and an effort called Alliances of Learning and Vision for Under Represented Americans, developed with the University of Alaska (BPXA 1998d).

As a result of continued industry and NSB efforts, some increase in employment of local residents in industry jobs is expected to occur, but the number employed is expected to be small.

The industry practice of providing work site housing and importing a significant segment of the workforce to the project site means that development induced local employment is likely to be small especially as they translate into employment of Alaska Natives.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities will likely generate jobs for local residents for several years above the level that may exist during operations. However, after the satellite pads have been shut down and termination activities have been completed, jobs associated with them will cease. If local residents have become substantially integrated into satellite operations and the community substantially dependent on revenues associated with their operation, and if other oilfields are not active in the area to provide jobs and contribute economically to the local economy and government revenues, the community will face a time of adjustment. Subsistence resources will be subject to fewer impacts, potentially improving subsistence opportunities. However, if local residents have come to utilize the oilfield roads to access subsistence resources and depend on oil reliant incomes to help support subsistence harvesting and the roads are dismantled and the income lost, local residents may find it difficult to realize any improvement in subsistence harvests.

4A.4.1.2 Alternative A – Full-Field Development Scenario Impacts on Socio-Cultural Characteristics

Complete development of the Alternative A – Full-Field Development Scenario would result in additional well pads, roads, and other facilities. To the extent that socio-cultural impacts are related to the number and extent of facilities developed, impacts from FFD would generally be greater than under the Alternative A - CPAI Development Plan.

SOCIAL ORGANIZATION

Impacts of the Alternative A – Full-Field Development Scenario would be the same as, or in some instances greater than, the impacts of the Alternative A - CPAI Development Plan. FFD would affect a much greater area of traditional subsistence use near Nuiqsut causing greater disruption of subsistence harvest activities. In particular, FFD could reduce the use and harvest of subsistence resources in the Colville River area, a key subsistence-use area for Nuiqsut. As community members avoid or are displaced from traditional use areas, they will travel farther and into the subsistence-use areas of other communities. This displacement could result in competition for resources between communities, extended absences of community members from their home village, and increased costs to pursue subsistence resources. To the extent that such disruption of subsistence harvest patterns and use occurs, it could stress the community social organization and lead to changes in underlying cultural values.

ECONOMIC ORGANIZATION

Depending on the extent of FFD, impacts to the cash economy could be significantly greater under this alternative. As described in the impact analysis found in Section 4A.4.2 on Regional Economy, the flow of revenues to the NSB and village corporations is correlated to oil production and price. Under FFD, oil production could be 4.5 to 10 times greater than under the Alternative A – CPAI Development Plan. To the extent that production generates revenues that flow to the community or community-based organizations, greater benefits would occur under FFD.

Enhancement of the cash economy from wage employment or income to local businesses providing local services is expected to be the same as under Alternative A – CPAI Development Plan.

INSTITUTIONAL / COMMUNITY SERVICES

Alternative A – FFD is not expected to increase demand for community services beyond what could occur under Alternative A – CPAI Development Plan. Without changes in demand for community services, changes to community institutions, other than those that would otherwise occur, are not expected.

COMMUNITY HEALTH AND WELFARE

No direct impacts in rates of crime, drug abuse, domestic violence, child abuse, or other community pathologies are expected as a result of FFD. To the extent that changes in subsistence harvest place stress on other elements of community structure, indirect impacts on these community health and welfare problems could occur. Section 4A.4.3 describes impacts of FFD on subsistence harvest. Since subsistence impacts are more likely under FFD, impacts to these community health and welfare problems, to the extent that they would occur, are also more likely under FFD.

POPULATION AND EMPLOYMENT

No changes to population growth rates or increased population as a result of migration of industry workers are expected as result of FFD. Any increases in direct or induced employment that would occur would likely be the same as under the Alternative A – CPAI Development Plan.

4A.4.1.3 Alternative A – Summary of Impacts (CPAI and FFD) on Socio-Cultural Characteristics

NUIQSUT

- Potential impacts to subsistence harvest and use could cause stress and change in community social organization. To the extent that they occur, these impacts would likely increase under Alternative A –FFD.

- Economic benefits are expected to occur as a result of Kuukpik and other corporate participation in construction and operations contracting. These economic impacts would likely be increased under FFD.

- No direct incremental impacts to community health and welfare concerns (crime, drug abuse, etc.) are expected as a result of the proposed project or FFD. To the extent that changes in community social organization occur, changes in community health and welfare could also occur. These impacts, to the extent that they occur, are more likely to occur under FFD.

- Very modest levels of direct employment in the construction and operation phases of the project is expected for Nuiqsut residents. Employment levels are not expected to increase under FFD. No change in the population growth rate is expected.

BARROW, ATQASUK, AND ANAKTUVUK PASS

- To the extent that subsistence hunters of these communities rely on subsistence-use areas in the Plan Area, there could be some effect on subsistence harvest in Barrow, Atqasuk, and Anaktuvuk Pass. However, the extent of these impacts is likely to be small and not sufficient to impact community social organization. Under FFD, impacts to subsistence harvest and use are expected to be greater, increasing the potential that changes to community social organization could occur.

- Economic benefits are expected to occur as a result of village corporate participation in construction and operations contracting. The impacts are expected to be greater under FFD.

- No direct incremental impacts to community health and welfare concerns are expected as a result of the applicant’s proposed action or FFD. To the extent that changes in community social organization occur, changes in community health and welfare could also occur. These impacts, to the extent that they occur, are more likely to occur under FFD.

- Very modest levels of direct employment in the construction and operations phases of the project is expected for Barrow residents under Alternative A – CPAI Development Plan or FFD. No change in the population growth rate is expected.

4A.4.1.4 Potential Mitigation Measures (CPAI and FFD) for Socio-Cultural Characteristics

Direct impacts to the socio-cultural characteristics of Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass are generally related to changes in subsistence harvest and uses, and economic benefits from revenue streams produced by oil production. Additional revenue is expected to accrue from contracting by North Slope-based Native corporations. Without intervention, employment opportunities for local residents are expected to be minimal. Indirect impacts include potential effects on community health and welfare.

Potential mitigation measures for both the Alternative A – CPAI Development Plan and the Alternative A – Full-Field Development Scenario are as follows:

- Mitigation measures to lessen the impacts to subsistence harvest and uses as discussed in Section 4A.4.3.

- No direct and immediate impacts are expected to community social organization, community services, or community health and welfare as a result of direct project impacts. If impacts in these sectors of community life occur as an indirect result of project development, such impacts are likely to occur incrementally and over a long period of time. A number of indicators of overall community welfare have been identified in previous studies prepared for the Kuukpikmuit Subsistence Oversight Panel (CRA 2002). CPAI would assist in continued monitoring of the indicator on a periodic basis to provide additional information to community leaders and appropriate social, health, and law enforcement organizations on overall community welfare. Such information could then be used to prioritize budgeting of community and NSB resources to address selected community welfare issues.

- To the extent practicable, appropriate job training and recruiting programs should be implemented to encourage industry employment of local residents to increase wages earned in the local community.

4A.4.1.5 Alternative A – Effectiveness of Protective Measures for Socio-Cultural Characteristics

Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations for general disturbance, general damage, and the chasing of wildlife as well as the wildlife stipulations for polar bears, caribou, and birds afford effective subsistence-resource protection, which in turn helps reduce impacts to the areas socio-cultural systems.

4A.4.2 Regional Economy

This section addresses the economic impacts associated with the ASDP. The analysis focuses on the income and employment that would result from construction and operation of facilities under the Alternative A – CPAI Development Plan and Alternative A – Full-Field Development Scenario.

The applicant's proposed action consists of five satellite oil production pads connected to the existing Alpine Central Processing Facility, located at CD-1. It is close to the North Slope Native village of Nuiqsut. Impacts have already been occurring for several years as a result of the initial Alpine Development Project at CD-1 and CD-2. The direct economic impacts from the Alternative A – CPAI Development Plan would both create new economic activity and extend the economic life of the existing Alpine Field into the future.

All of the economic "impacts" that have been identified are in fact increased revenues and income that are expected to accrue to the state, the NSB, and Nuiqsut (including through Nuiqsut's Native corporation). In Section 4A.4.3, Subsistence Harvest and Uses, impacts to subsistence hunting and gathering are discussed. These impacts also could have an economic consequence; however, the economic consequences have not been given a value because the loss of subsistence harvest or increased cost of subsistence harvest has not been determined.

4A.4.2.1 Production

The existing Alpine Field has been producing oil and related economic activity since 2000. Without the applicant's proposed action, production from CD-1 and CD-2 would continue to provide jobs and revenues. However, without the ASDP, the level of production and related economic activity from the Alpine Development Project would increase slightly between 2003 and 2008 and then decline after that point.

The economic impacts of Alternative A would be derived from royalties, taxes, and other payments related to production and employment income from construction and operation. For North Slope communities and the State of Alaska, the larger components are royalties, taxes, and other payments related to production. Implementation of Alternative A would be expected to extend the life of the ASDP to approximately 2015 before production falls below current levels. CPAI's plans to extend production capacity for the Alpine Central Processing Facility from the current capacity of 105,000 bbl of oil per day would increase to 145,000 bbl per day in 2004 to 2005 (see Table 2.3.12-1, Potential Schedule for Processing Facility Expansion).

Figure 4A.4.2-1 shows the projected oil production from the existing Alpine Field (CD-1 and CD-2) and the proposed ASDP (CD-3 through CD-7). The data used to portray oil production in Figure 4A.4.2-1 were developed by the State of Alaska (Alaska Department of Revenue [ADR] 2003a). Analysts with the ADR forecast oil production throughout Alaska as an integral part of their annual state revenue estimate that is used by the Alaska legislature in developing the budget. The areas on this graph that exceed the projected processing capacity are due to the production model used in the projections. Under actual operating conditions, the production would be reduced to remain within the processing capacity limit.

Production estimates for the wells and additional production facilities assumed to accrue as part of FFD are presented in Table 4A.4.2-1 for a 20-year period. The last line in Table 4A.4.2-1 shows the total production for each of the production units, including production for years not included in the table.

TABLE 4A.4.2-1 PROJECTED OIL PRODUCTION FOR EXISTING, CPAI DEVELOPMENT PLAN, AND FFD SCENARIO: 2003 THROUGH 2023 (IN BARRELS PER DAY)

YEAR	CD-1 and CD-2	CD-3	CD-4	CD-5	CD-6	CD-7	NPR-A FFD[a]
2001	40,000						
2002	96,000						
2003	98,000						
2004	100,000						
2005	103,000						
2006	103,000						
2007	103,000	20,000	14,000				
2008	103,000	20,000	14,000				10,000
2009	90,000	20,000	14,000		2,500		12,000
2010	73,800	17,600	11,900		20,000		20,000
2011	61,254	15,488	10,115		20,000		9,600
2012	51,453	13,629	8,598	16,000	20,000	20,000	22,680
2013	43,735	11,994	7,394	16,000	17,000	20,000	33,644
2014	37,612	10,555	6,433	15,000	14,450	20,000	62,915
2015	32,723	9,288	5,661	13,350	12,283	17,600	71,932
2016	28,796	8,174	5,038	11,748	10,563	14,960	83,942
2017	25,628	7,193	4,534	10,338	9,190	12,716	92,121
2018	23,066	6,401	4,081	9,096	8,087	10,936	227,647
2019	20,759	5,761	3,673	8,006	7,197	9,514	231,877
2020	18,891	5,185	3,306	7,045	6,478	8,372	235,341
2021	17,191	4,667	2,975	6,200	5,830	7,451	238,016
2022	15,643	4,200	2,707	5,456	5,247	6,706	240,237
2023	14,392	3,780	2,464	4,856	4,722	6,036	242,080
Cummulative Total Production[b]	**475,400**	**76,000**	**50,300**	**60,000**	**71,800**	**73,600**	**1,657.800**

Source: ADR, Tax Division. Unpublished files from Spring 2003 Revenue Sources Book.

Notes:

[a] FFD in this table is based upon assumptions provided by the BLM.

[b] This figure shows the total estimated production in thousands of barrels over the life of the production area, including years past 2023.

Figure 4A.4.2-2 also shows the effect of adding the projected FFD under the BLM's production assumptions. A map showing the projected locations for FFD was shown in Figure 2.4.1.2-1. This figure shows 22 hypothetical production areas (HP-1 through C HP-22) and two hypothetical processing facility/production areas (HPF-1 and HPF-2).

The BLM estimates an average of 50 MMbbl (with a range of 25 MMbbl to 150 MMbbl) for HP-1 through HP-22 and an average of 250 MMbbl (with a range of 150 million to 300 million) for the two processing/production pads. Further the BLM estimates the timing for development of one of the processing/production units in 15 years with the second to follow in another 10 years (BLM 2003).

To estimate production for FFD, the BLM assumed that each of the 22 hypothetical production pads (HP-1 through HP-22) would have an average production of 50 MMbbl. To this was added 2 times the projected production from HPF-1and HPF-2 (250 MMbbl), resulting in a total production from FFD of 1.6 Bbbl.

Production streams for FFD under the BLM assumptions were developed using the method described above. To determine the timing of production, production pads in the FFD had to be linked to specific processing facilities; the production pads were assumed to be brought online in different years. These groupings were made based on the proximity or each production pad to the most likely processing area. Thus, it was projected that production from HP-1, HP-3, HP-4, HP-5, HP-6, HP-7, HP-8, HP-9, HP-11, HP-12, HP-13, HP-14, and HP-15 would go to the existing Alpine Central Processing Facility at CD-1. It appears that most of this production also would be outside the boundary of the National Petroleum Reserve-Alaska. The production from HP-2, HP-10, HP-16, HP-17, and HP-19 would go to HPF-1, and the production from HP-18, HP-20, HP-21, and HP-22 would go to HPF-2.

Figure 4A.4.2-2 shows the estimated FFD production resulting from the BLM assumptions. The additional production from FFD is presented by increment grouped by processing facility: APF-1, HPF-1, and HPF-2. The gap between peak production for HPF-1 and HPF-2 is due to the hypothetical timing of the production assumptions. It is most likely that under actual production conditions the operating companies would work to schedule production so that this gap would not exist. The production assumptions shown in Figure 4A.4.2-2 provide the basis for determining the economic effects of FFD.

As illustrated in Figure 4A.4.2-2, the addition of FFD results in much higher average production per year and significant extension of production into the future. Figure 4A.4.2-1 shows that by 2023, production under the Alternative A – CPAI Development Plan would fall to less than 40,000 bbl per day, or less than 30 % of the peak production of 145,000 bbl per day. Figure 4A.4.2-2 shows that FFD production would not decline to this level until 2042.

4A.4.2.2 Alternative A – CPAI Development Plan Impacts on Regional Economy

REVENUES

ROYALTY AND TAX IMPACTS

As demonstrated in Section 3.4.2, the State of Alaska depends heavily upon oil royalties and taxes to fund its annual operating budget. The state funds approximately 80 % of its general fund unrestricted revenues from petroleum revenue, and 35 % or more of all state revenues are derived from the oil industry (ADR 2003).

Figure 4A.4.2-1 showed that oil production and revenues from the Alpine Field would begin to decline in 2008 without the ASDP. The increased production from Alternative A shown in Figure 4A.4.2-1 would contribute both state and federal tax revenues on an annual basis. Table 4A.4.2-2 shows the projected state and federal revenues for the period from 2003 through 2020 for the Alternative A – CPAI Development Plan. These estimates are based on the revenue model used by the ADR to forecast state revenues. The model is dependent upon a number of assumptions, the most important of which are level of production and forecasted wellhead value for oil. The production estimates used for both the Alternative A – CPAI Development Plan and the Alternative A – Full-Field Development Scenario are illustrated in Figures 4A.4.2-1 and 4A.4.2-2. The ADR publishes estimated projections of future oil prices as an integral component of their annual spring and fall revenue forecast for the state. The current oil price forecast by the ADR is shown in Table 4A.4.2-3. To the extent that future oil prices differ from these projections, revenue projections based on this projection are subject to underestimation or overestimation.

Royalty tax payments from within the National Petroleum Reserve-Alaska are treated differently from those from other state or federal lands, and Alternative A includes a portion of the ASDP within the boundaries of the National Petroleum Reserve-Alaska (CD-5 at least partially and CD-6 and CD-7 entirely). Federal law establishes a requirement that 50 % of lease sale revenues, royalties, and other revenues would be paid to the State of Alaska. However, that payment is conditional upon the use of the state's share for (a) planning, (b) construction, maintenance, and operation of essential public facilities, and (c) other necessary provisions of public service. The law stipulated further that the state should give priority to use by subdivisions of the state most severely impacted by development of oil and gas leased under the section (ADCED 2003).

In the period between 1987 through 1996, when the program became inactive because of lack of revenue from the National Petroleum Reserve-Alaska, $9.7 million was allocated to community projects in the region. With new lease sales in the National Petroleum Reserve-Alaska in 1999, the program became active again, providing $31.4 million in grants to communalities for 1999, 2001, and 2002. There are current applications for a total of $53.2 million for projects by the communities of Anaktuvuk Pass, Atqasuk, Barrow, the NSB, Nuiqsut, and Wainwright. During the program, Nuiqsut has received just under $9 million for community projects. The National Petroleum Reserve-Alaska Impact Mitigation Program provides direct economic support from oil development within the National Petroleum Reserve-Alaska to communities within the region.

PROPERTY TAX

The property tax for the ASDP would be based on the assessed valuation of the facilities developed onsite. The annual levy is based on the full and true value of property taxable under AS 43.56. For production property, the full and true value is based on the replacement cost of a new facility, less depreciation. The depreciation rate is based on the economic life of the proven reserves. Pipeline property is treated differently from production facilities. It is valued on the economic value of the property over the life of the proven reserves. Typically, the economic value is based on the present value of all future income streams from the pipeline.

TABLE 4A.4.2-2 SUMMARY OF STATE AND FEDERAL REVENUES FOR CD-3 THROUGH CD-7

Year	State Royalty[a]	State Oil Production Tax[a]	Federal Royalty[a]
2003	$0.0	$0.0	$0.0
2004	$0.0	$0.0	$0.0
2005	$0.0	$0.0	$0.0
2006	$0.0	$0.0	$0.0
2007	$25.0	$0.0	$0.0
2008	$24.9	$0.0	$0.0
2009	$26.1	$0.5	$1.1
2010	$30.7	$4.2	$9.1
2011	$29.7	$4.4	$11.2
2012	$43.0	$9.9	$26.9
2013	$38.6	$7.1	$24.7
2014	$34.9	$5.4	$22.9
2015	$30.0	$2.8	$19.5
2016	$25.6	$1.5	$16.5
2017	$21.9	$0.7	$13.9
2018	$18.9	$0.3	$11.9
2019	$16.3	$0.1	$10.1
2020	$14.2	$0.0	$8.8

Source: calculated by ResourcEcon from Dept. of Revenue data
Notes:
[a] Revenues are shown in millions of dollars.

TABLE 4A.4.2-3 PROJECTED OIL PRICES

Fiscal Year	Market Price – U.S. West Coast $/barrel	Wellhead Value $/barrel
2004	$25.28	$18.72
2005	$21.67	$14.99
2006	$22.00	$15.15
2007	$22.00	$15.05
2008	$22.00	$15.01
2009	$22.00	$15.05
2010	$22.00	$14.96
2011	$22.00	$14.77
2012	$22.00	$14.83
2013	$22.00	$14.69
2014	$22.00	$14.53
2015	$22.00	$14.34
2016	$22.00	$14.11
2017	$22.00	$13.87
2018	$22.00	$13.63
2019	$22.00	$13.21
2020	$22.00	$12.97

Source: Alaska Department of Labor. Oil price forecasts used in the State Revenue Forecast, Spring 2003.

The state property tax rate is 20 mills. A local tax is levied on the state’s assessed value for oil and gas property within a city or borough and is subject to local property tax limitations. The 2002 property tax rate for the NSB was 18.5 mills (ADCED 2003) leaving the state portion of the property tax at 1.5 mills.

The NSB is also heavily dependent upon oil revenue from property taxes. In 2001, 95.44 % of property taxes received by the NSB came from BPXA, Phillips Alaska, Alaska Pipeline Services Company, Nabors Alaska Drilling, and Halliburton Company (NSB 2001).

The NSB faces a declining property tax base because of depreciation of petroleum-production related facilities that comprise most of the assessed valuation. The real property assessed valuation for the NSB has declined from $11.5 billion in 1992 to $9.4 billion in 2001 (NSB 2001). The ASDP Alternative A would help expand assessed property valuation and resulting taxes to the NSB.

An estimate for the potential property tax revenues from Alternative A can be calculated using a unit factor estimate of $0.50 per barrel (ADR 2003b). Using the point estimate of $0.50 per barrel, we can calculate the property tax value from the production figures in Table 4A.4.2-1. The estimated property tax, using the per barrel unit factor, is shown in Table 4A.4.2-4.

TABLE 4A.4.2-4 PROJECTED PROPERTY TAX REVENUES: ALTERNATIVE A – CPAI DEVELOPMENT PLAN

Year	CD-3 through CD-7 Daily Production[a]	Estimated Property Tax	
		NSB	State of Alaska
2007	34,000	$5,739,625	$465,375
2008	34,000	$5,739,625	$465,375
2009	34,000	$5,739,625	$465,375
2010	49,500	$8,356,219	$677,531
2011	45,603	$7,698,356	$624,191
2012	78,227	$13,205,695	$1,070,732
2013	72,388	$12,219,999	$990,811
2014	66,438	$11,215,565	$909,370
2015	58,182	$9,821,849	$796,366
2016	50,483	$8,522,161	$690,986
2017	43,971	$7,422,854	$601,853
2018	38,601	$6,516,331	$528,351
2019	34,151	$5,765,116	$467,442
2020	30,386	$5,129,537	$415,908
2021	27,123	$4,578,701	$371,246
2022	24,316	$4,104,845	$332,825
2023	21,858	$3,689,904	$299,181

Notes:
[a] Daily production in barrels

This analysis shows NSB revenues derived from the proposed development of CD-3 through CD-7. They would be expected to increase from approximately $5.7 million annually in 2007 when this revenue stream begins, to $13.0 million in 2012, when it would peak. It would decline to $3.7 million in 2023, the last year estimated. Incremental revenue to the State of Alaska would be $0.465 million in 2007, rise to approximately $1.1 million in 2012, and then decline to $0.3 million in 2023. These revenues represent an incremental increase approximately 2 percent to 4 percent of total NSB revenues (based on 2001 revenues – See discussion in Section 3.4.2). Increased property tax revenue would represent an incremental increase in tax revenue to the state of less than 1 percent.

CAPITAL EXPENDITURES

Indirect economic impacts would result from project capital expenditures. Detailed information on the capital expenditure for the Alternative A – CPAI Development Plan is presented in Appendix J. The capital expenditures for Alternative A are estimated to be $1.061 billion. These expenditures would occur over an 20-year period.

Most materials and capital equipment would likely be purchased outside of Alaska and would be shipped to the job site. However, some portion of the total capital expenditures would be made within Alaska, mostly in Anchorage and Fairbanks. Expenditures in Anchorage or Fairbanks might include construction of a module or project supplies. Limited expenditures might be made within Barrow or Nuiqsut. Such expenditures would likely be provision of goods and services to support construction activities**.**

EMPLOYMENT

Project-related employment from the Alternative A – CPAI Development Plan would consist of construction employment and operations employment. Construction income and earnings would be one of the most easily visible effects of the project. These impacts also are sequentially the first economic impact to be realized. For large remote projects such as the ASDP, as much as half of the total project expense is typically directed to labor costs.

Many of the construction workers hired would need skills and experience in drilling and pipeline construction. Most of the workers would be hired through union halls in Alaska for the respective tasks. However, most of the workers might come from out of state, because Alaska does not have a resident workforce with the range of skills necessary. As discussed later in this section, CPAI has had some success in providing employment opportunities for residents of Nuiqsut; however, in total these opportunities reflect a relatively small number of jobs. (See discussion in Section 3.4.1.6 – Population and Employment)

Table 4A.4.2-5 summarizes drilling manpower for the Alternative A – CPAI Development Plan. Construction crews would be housed at production pads, the Kuparuk Operations Center, or temporary camps. Small temporary camps could also be used during drilling operations.

Manpower requirements reflect a maximum of 60 personnel residing at the temporary drilling camp at each of the four road-connected pads in the Alternative A – CPAI Development Plan. Winter drilling at CD-3 would require an additional 15 people, for a total of 75 personnel.

TABLE 4A.4.2-5 DRILLING MANPOWER REQUIREMENTS

Time Period	Alternative A – CPAI Development Plan Manpower Required
Summer 2004	0
Winter 2004–2005	75
Summer 2005	0
Winter 2005–2006	75
Summer 2006	60
Winter 2006–2007	75
Summer 2007	60
Winter 2007–2008	135
Summer 2008	60
Winter 2008–2009	135
Summer 2009	60
Winter 2009–2010	195
Summer 2010	120
Winter 2010–2011	195

Source: Table 2-3, CPAI 2003n

CPAI estimated that a total of 3,000,000 man-hours would be expended between 2004 and 2010 for construction and operation of CD-3 through CD-7. The total work force is projected to peak at over 500 workers in 2006. Engineering and design work for the alternative are anticipated to require 500,000 man-hours. Offsite fabrication, which could occur in Fairbanks, Anchorage, or Nikiski, is estimated to require 250,000 man-hours (CPAI, RFI #85 response).

The Alaska Department of Labor (ADL) shows statewide average wages for all oil-related manufacturing of $31.24 for June 2003 (ADOL 2003a). The product of this wage rate and the estimate of 3,000,000 man-hours cited above results in a total project labor expenditure of $93.7 million.

Similarly, based on the average civil engineer wage rate of $32.50 within Alaska for oil-related jobs and the man-hour estimate of 500,000, the projected total labor expenditure for engineering and design is estimated to be $16.2 million. Based on the average Alaska wage rate for plumbers, pipefitters, and steamfitters of $26.51, and the estimate of 250,000 hours for fabrication, the estimated labor expenditure for this category totals $6.6 million (ADOL 2003b).

The specific profile of employment and skill area for Alternative A is not yet available. Typical job skill categories for similar projects include the following: laborers, teamsters, operators, general foremen, welders, welder's helpers, heavy duty mechanics, auto weld technicians, office engineers, office clerks and technicians, truck mechanics, project managers, field engineers, project engineers, office managers, safety managers, fitters, electricians, security guards, medics, and welder repair.

Most construction jobs are likely to be filled by workers from outside the region or from outside Alaska. The current level of participation by residents of the NSB in petroleum-related employment is relatively limited. In the 2000 census, there were 2,990 males and 1,348 females in the workforce for the communities comprising the NSB. The job category of mining, which includes petroleum-related employment, included 33 jobs in 2000, 30 of which were filled by Alaska Native residents of the NSB. There were 207 workers residing in the NSB communities working in construction, 139 of whom were Alaska Natives. Among female workers, there appeared to be very little participation in petroleum-related jobs in 2000 (ADOL 2003c).

Operations personnel for Alternative A would be based at production pads. Anticipated staffing levels are shown in Table 2.3.3-2 (Section 2). There would be 22 jobs associated with operations for CD-3 through CD-7. Total annual operations labor expenditures for these workers are not available.

Section 3.4 described a number of jobs and economic activity in Nuiqsut as a result of the existing Alpine Field. These job opportunities include participation in joint venture companies to provide oilfield services, direct employment, funding of subsistence panel and research jobs, and others. These employment opportunities are important to the residents of the community, particularly given the residents' relatively low opportunity for employment.

LOCAL ECONOMIC ACTIVITY

A number of economic impacts to Nuiqsut and other local communities were described in Section 3.4. The impacts discussed include direct employment and earnings to residents; funding for the Kuukpikmuit Subsistence Oversight Panel, increased economic activity at Nuiqsut businesses such as the Kuukpik Hotel, and revenues to Nuiqsut Village Corporation resulting from joint-venture business activities in the region.

Without a continuing and increased oil industry, these effects would begin to decline slowly, beginning in 2008. New economy activity represented by the Alternative A – CPAI Development Plan is expected to increase the level of local economic activity over the current level, and those impacts would be extended many years into the future.

In addition, because some of the facilities of the Alternative A – CPAI Development Plan would be within the National Petroleum Reserve-Alaska, the local communities would receive direct funding assistance through the

National Petroleum Reserve-Alaska Impact Mitigation Program. The expenditures under this program were described in Section 3 and would be substantially expanded under this alternative.

4A.4.2.3 Alternative A – Full-Field Development Scenario Impacts on Regional Economy

Estimates of the amount and timing of production related to FFD were discussed in Section 4A.4.2.2.

REVENUES

ROYALTY AND TAX IMPACTS

The economic effects from royalty and tax payments can be determined only if the specific location relative to BLM-managed lands is known (that is, whether oil is derived from federal or non-federal land). Because the description of FFD is hypothetical, it was assumed that impacts of FFD would be generally proportional to production in each year. In 2012, for example, the full-field production under BLM assumptions is 4.5 times that of the assumptions of the ADR for development of the applicant's proposed action. The ratio changes from year to year, but full-field production under BLM assumptions increases over time. In 2023, the full-field production under BLM assumptions is 10 times that of the CPAI's proposal assumptions of the ADR.

CAPITAL EXPENDITURES

There currently are no estimates for capital expenditures for FFD.

EMPLOYMENT

Table 4A.4.2-5 summarizes the drilling manpower requirements for the applicant's proposed action. FFD assumes a one-rig drilling program, so the duration of drilling activities would increase. The FFD one-rig program would continue an additional 1 to 2 years per additional production pad, depending on whether drilling is in winter only or year-round.

There is currently no estimate available for total project employment for FFD.

LOCAL ECONOMIC ACTIVITY

Increases in employment and income to village corporations from contracts provided during construction and operations are expected to be similar or greater than the levels achieved under the Alternative A – CPAI Development Plan. However, the portion of tax and royalty revenues and the availability of grants that are proportional to production would be substantially higher under FFD.

ABANDONMENT AND REHABILITATION

Removing facilities and rehabilitating the land will generate substantial employment for several years. The number of jobs created may be comparable to that for construction if gravel fill is removed. Once oil ceases to flow from the satellites and termination activities are complete, economic stimulus from the satellites—with the exception of relatively insignificant employment from monitoring and long-term rehabilitation—would cease.

4A.4.2.4 Alternative A – Summary of Impacts (CPAI and FFD) on Regional Economy

- The Alternative A – CPAI Development Plan would provide an incremental increase in federal, state, and local tax revenues. This increase would be 2 to 4 % (of 2001 revenues) for the NSB. It would be less than 1 % of state tax revenues. Increased revenues under FFD could be 4.5 to 10 times the annual revenue estimated for the Alternative A – CPAI Development Plan, depending on production in any given year.

- The NSB would benefit from the expanded property tax base that would help fund government services to residents.

- The NSB and village corporations also would experience increased economic activity in the region, increased opportunity for direct employment of local residents, and increased opportunity for grants under the National Petroleum Reserve-Alaska Impact Mitigation Program. As a result of this program, oil lease sale fees and royalties from the National Petroleum Reserve-Alaska have a disproportionately large beneficial effect on communities in the region.

- There could be economic impacts to subsistence harvesting activities from Alternative A resulting from increased travel costs and increased travel times. The more densely developed FFD scenario for Alternative A would likely exacerbate these impacts (see discussion in Section 4A.4.3, Subsistence.).

4A.4.2.5 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Regional Economy

Currently, very few residents of the region obtain employment in the oil industry. Job training, educational funding, and future employment programs could help to mitigate loss of opportunity for participants in the traditional subsistence lifestyle.

4A.4.2.6 Alternative A – Effectiveness of Protective Measures for Regional Economy

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that change potential economic effects. This EIS does identify training and employment programs as a potential mitigation measure.

4A.4.3 Subsistence

4A.4.3.1 Alternative A – CPAI Development Plan Impacts on Subsistence

CONSTRUCTION PERIOD

Under the Alternative A – CPAI Development Plan, CPAI proposes to use two gravel mines: the existing ASRC Mine Site and Clover. Excavation would take place in the winter and involve the use of pneumatic drills, earthmovers, and blasting. The ASRC Mine Site would require an ice bridge across the Colville River. The ASRC Mine Site is located within the current Nuiqsut use area for wolf and wolverine, winter and summer caribou, fish, and moose. Clover is located within the current Nuiqsut use area for wolf and wolverine, winter caribou, fish, and moose. Barrow residents occasionally use the mine areas for the harvest of winter caribou, wolf, and wolverine, and Anaktuvuk Pass residents occasionally use these areas for the harvest of fish and caribou. Noise, lights, traffic, and blasting during construction at the proposed mines would divert, displace, or both divert and displace caribou and furbearers (Section 4A.3.4), resulting in decreased availability of these resources to hunters near these locations. Fish availability in the areas near the proposed mines could decrease if noise and vibration from traffic and gravel extraction divert fish from their habitats and because changes in water levels in adjacent connected lakes and streams caused by gravel extraction result in a decline in overwintering fish habitat (Section 4A.3.2.1). A North Slope Inupiat hunter who has observed wildlife displacement associated with gravel pits said,

> “These gravel pits that are being used to support these activities, the gravel pits, the geese, when they're migrating from the Lower 48s, from out there, they are now going to these gravel pits. They're not following their usual migration anymore. I watched that first hand also over a period of time. So those animals over there are being displaced, is what I'm saying. And I got to see that firsthand over a period of time.” (Frederick Tukle Sr. 2001 Liberty Scoping, Barrow)

The proposed five satellite drilling and production pads would divert key subsistence resources (caribou, wolves, and wolverines) and could consequently decrease resource availability in currently used subsistence areas in the vicinity of the five pads. The construction of the proposed production pads would reduce access within current subsistence-use areas as hunters avoid construction areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. Based on Pedersen et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development with approximately 78 % of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River, 51 % of the 1999 and 2000 harvests occurring greater than 16 miles and 27 % occurring six to 15 miles from Alpine development. Construction and operation of these pads and associated infrastructure will contribute to a perception by Nuiqsut residents and subsistence users of being surrounded by development. Impacts are expected to be short term and localized as construction will be limited to 1 to 2 years. However, oil and gas production is expected to be localized, but continue for a longer period.

Gravel pad placement would affect waterfowl nesting habitat (CD-4, CD-5, CD-6, and CD-7) (Section 4A.3.3). Production pad CD-4 would be located within 1,000 feet of the Nigliq Channel and a subsistence fish camp. The Nigliq Channel area is an important historical and current subsistence-use area for fish, waterfowl, and caribou. This area is especially important for the subsistence winter fish harvests (Figures 3.4.3.2-13 and 3.4.3.2-14). The proposed location for CD-6 is within the previously stipulated 3-mile sensitive area around Fish Creek and within the documented winter subsistence-use area for caribou, wolf, and wolverine. The Fish Creek area is proportionately the area with the highest use for Nuiqsut's winter harvest of caribou (Figure 3.4.3.2-6), and 25 % of Nuiqsut's caribou harvest for 1993, 1994–1995, 2001, and 2002 come from the Fish and Judy creeks area (Figure 3.4.3.2-7). Fish Creek is also an important Nuiqsut harvest area for geese (more than 45 %) (Figure 3.4.3.2-15), and more than half of wolves harvested by Nuiqsut hunters come from the Fish and Judy Creek areas (Figure 3.4.3.2-21). Production pads CD-3 and CD-4 would be within the current Nuiqsut use area for eider, seal, wolf, wolverine, fish, and winter and summer caribou. Production pad CD-4 also would be within the current Nuiqsut use area for moose. Production pads CD-5, CD-6, and CD-7 would be located within the current Nuiqsut use area for wolf, wolverine, and winter caribou. Production pads CD-5 and CD-6 would be located within the current Nuiqsut use area for moose. Figures 3.4.3.2-1 through 3.4.3.2-4, 3.4.3.2-8, 3.4.3.2-17, and 3.4.3.2-23 illustrate subsistence use areas for Nuiqsut. Frank Long Jr. of Nuiqsut, a hunter and executive director of the Kuukpik Subsistence Oversight Panel, stated during ASDP scoping, "… in the area that CD-5, 6, and 7, especially 7, is a hunting area where we do our hunting inland and with furbearing animals. And CD-6 is the one that's close to the Fish Creek area which we do fishing during the summer." In short, the proposed production pads would be located in key subsistence harvest areas in both the Fish-Judy Creeks Facility Group and the Colville River Delta Facility Group.

Construction of roads could alter or restrict movements of key subsistence species such as caribou, wolves, and wolverine. Construction of bridges and ice roads could affect the availability of fish in the Nigliq Channel and area lakes by reducing overwintering habitats (Section 4A.3.2.1). The proposed Nigliq Channel bridge is located in a key subsistence harvest area for fish; however, construction would occur from December to April after the key winter harvest season (e.g., October and November). As depicted in Figure 3.4.3.2-11, 55 % of fish are harvested in October. More than half of Nuiqsut's subsistence fish are harvested along the Nigliq Channel (Figure 3.4.3.2-13). Ice roads are also noted for accumulating garbage, which attracts some species.

As one interviewed hunter noted, "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears have trash inside of them. Seals [have] plastic pop rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over." (Stephen R. Braund & Associates 2003a Field Interviews)

Ice roads also have been noted to be grounded to the bottom of waterways, changing the normal patterns of break-up and reducing fish habitat. One resource user described his recent hunting trip by boat: "A few days ago [late June], the ice was out 7 miles; we followed it to Thetis Island. Usually the ice is out around Thetis Island, but the ice road was intact and it kept the ice from going out. We almost got boxed in." (SRB&A 2003a, Field Interviews)

During pipeline construction, availability of subsistence resources, especially caribou, would be reduced along the construction corridor and hunter access would be reduced as hunters avoid shooting near workers and equipment. Effects from construction are expected to last 2 years and are expected to be primarily local in extent. Pipeline construction would affect local availability of key subsistence resources (caribou, waterfowl, fish, wolves, wolverine, and seals) because of displacement and would occur in seasonal and general use areas for key subsistence resources. Subsistence access would be affected as subsistence users avoid construction areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. Subsistence hunters consequently would travel farther at greater costs and effort. The key resources are harvested during more than one season each year; they have been used for multiple generations, and the affected areas are used for multiple resources each year. Effects from construction would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses.

OPERATION PERIOD

The operation of the gravel mines would be intermittent following the completion of the construction phase. The mines would be open and gravel stockpiled as needed for maintenance of the pads, roads, airstrips, and boat ramps. The effects of subsequent mine operation would depend on the season and extent of use. Spring and summer use could disturb or deflect waterfowl, fish, and caribou from the area; winter use could deflect caribou, wolf, and wolverine from the area. Significant use of the mine sites during spring and summer seasons is not expected because most construction will be conducted during the winter and there would be no road access to the mine sites when ice roads are not available.

The operation of facilities on the gravel pads would have a number of effects on subsistence uses. The gravel pads themselves create habitat for arctic foxes, which could den in the loose gravel. There is little perceived advantage in having more foxes available, however, as stated by elder Bessie Ericklook in 1979:

> “Trapping was abundant east of here. Now, we don't go over because of the oilfield. Just recently, it is known that the foxes are very dirty, discolored, and rabid in that area. Trapping is done elsewhere.” (MMS 1979 Sale BF, Nuiqsut)

Noise from operations such as pumps, generators, and drilling machinery could deflect terrestrial mammals, fish, and waterfowl from the immediate area and make them less available to subsistence harvesters at those locations. According to one interviewed hunter, “The vibration of horizontal drilling bothers animals and makes them afraid. The migration route of the Central Arctic (caribou) herd (CAH) changed because of this.” (SRB&A 2003a, Field Interviews)

Section 4A.3.4 describes how caribou at Prudhoe Bay use gravel pads for insect relief. Caribou habituation to gravel pads and other oilfield infrastructure changes the value of the caribou to subsistence users, who view these habituated caribou as contaminated and not behaving correctly. Frank Long Jr. stated in the Nuiqsut ASDP scoping, “We will have the same problem we did in the Prudhoe Bay and the Kuparuk area with our caribou. Right now I call our caribou that are existing around here that don't go nowhere our ‘industrial dope addict caribou.’ They [are] already sick and nobody's doing anything about them.” Sick caribou have been harvested by local hunters, as noted by one interviewed hunter, “I’ve seen a few sick caribou, with green meat, pus in joints, bare spots. Hard to say what the cause is…” (SRB&A 2003a, Field Interviews). Inupiat hunters prefer fast, healthy caribou, instead of habituated caribou, which are perceived to move slower. One hunter stated, “Fast ones are the healthy ones, they are worth taking home.” (SRB&A 2003a, Field Interviews)

Subsistence hunters have expressed a preference for hunting away from industrial activity areas for safety reasons. As noted in NRC (2003:156), “Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread.” Based on Pedersen et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development with approximately 78 % of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River and 51 % of the 1999 and 2000 harvests occurring greater than 16 miles and 27 % occurring 6 to 15 miles from Alpine development. Therefore, the production pads near the Nigliq Channel and Fish Creek areas would reduce subsistence access to traditionally important subsistence uses at those locations. Isaac Nukapigak noted in the 2003 ASDP scoping in Nuiqsut:

> “The stipulation that's been part of the Northwest ([Northeast] sic) Integrated Action Plan EIS where there's seven line ([seventy-nine] sic) stipulations that have been implemented by BLM having a buffer zone in these sensitive, very sensitive area that, you know, lakes and streams, where that's our channel, you know, that's what we depend on to navigate to our subsistence resource to gather.” (2003 ASDP Nuiqsut Scoping Transcripts)

Airstrip operation would disturb and temporarily displace subsistence species (caribou and spotted seals) from the vicinity of airstrip and landing areas. According to area studies and scoping testimony, low-altitude flights (helicopter and scientific survey flights) divert subsistence species from air transport corridors and survey transects (see Section 4A.3.4). Nuiqsut's mayor Rosemary Ahtuangaruak described the displacements of subsistence species by aircraft and its effect on hunters:

> **"**When I went camping last year, I waited 3 days for the herd, to have a helicopter to divert them away from us. When they were diverted, we went without. We have had to deal with harassment. We had over flights three times while trying to cut the harvest. It is disturbing. The next year we had a helicopter do the same thing, but it was worse. They were carrying a sling going from Alpine to Meltwater, another oilfield. It went right over us three times. The herd was right there and it put us at risk. I had my two young sons with me and it made me very angry. What am I to do when the activities that have been handed down for thousands of years to our people are being changed by the global need for energy?" (Mayor Rosemary Ahtuangaruak 2003 ASDP Scoping, Nuiqsut)

Wildlife studies, some of which are associated with monitoring or planning oil and gas activities, prompted another Nuiqsut resident to make a similar observation:

> **"**These wildlife folk that see it—they‘ve witnessed, I guess they are wildlife folks, that walk in the country and looking at birds and things in the Colville River Delta, maybe the east side, down by Ulumniak (ph) that's next to—not far from the old Nuiqsut site, they‘re monitoring these birds and go to and fro to these places with a chopper—upsets, disrupts, displaces—perhaps some of their only opportunity to go get their game, especially caribou, in the area are scared and may their run off because of these impediments that arrive are not natural. Naturally, they would walk along the coast where they're at and be able to harvest their caribou." (Ruth Nukapigak 1998 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Referring to the effect of aircraft on wildlife, Nuiqsut residents stated, "Sometimes the aircraft from Alpine chase the caribou up the river," and "Helicopters are flying around when we are doing caribou and geese hunts. Before Alpine, there was complete silence." (SRB&A 2003a, Field Interviews)

Interviewed hunters correlate aerial activity with subsistence resource deflection. One hunter stated, "It varies whether we have a lot of activities going on. When there are a lot of activities going on, we hardly see any or they [caribou] change their migration route. Oil and gas, airplanes, helicopters, bird survey people—airplane, floatplanes. Either there are less caribou or they are changing migration with activities. I don't know which." (SRB&A 2003a, Field Interviews)

Therefore, local hunters report that aircraft operation affects the availability of subsistence resources in usual hunting areas.

Roads during the operational period would affect terrestrial mammals and waterfowl through deflection and habitat loss (See Sections 4A.3.4 and 4.A.3.3). Vehicular traffic could deflect waterfowl during the operational phase of the applicant's proposed action. Disturbance of waterfowl has been documented most often within 50 meters of roads; however, some disturbance has been reported for birds as far as 150 to 210 meters from roads. Deflection of birds from their usual habitat would affect the availability of birds as a subsistence resource at those locations. Waterfowl also would be subjected to disturbances related to aircraft and boat traffic, noise from facilities, and pedestrian traffic during the summer breeding season, especially during the pre-nesting period. Terrestrial mammals would be disturbed and displaced by vehicle traffic on the roads between CD-1 and CD-4 and CD-2 and CD-7. Activity on the facility pads and airstrips could disturb caribou. Use of the Alternative A roads by local residents in addition to industry would result in higher levels of traffic and increased disturbance and deflection. Inupiat hunters have observed the effect of roads and pipelines in Prudhoe Bay, Kuparuk, and other locations, and one hunter summarized these observations by saying,

> "The Prudhoe Bay spine road is like a gate: the caribou get corralled in the area by roads, traffic, pipeline reflections, and staging. They get confused. They are scared to cross the pipelines, they are as scary as a grizzly bear would be to the animals. Some caribou are driven south, others are driven to the coast. If more roads are built, then there will be more blockage of the caribou. They will get stuck in the oilfields like a corral. The ones stuck south stay south and get little insect relief, while those going north get to the beach and the coast and get relief." (SRB&A 2003a, Field Interviews)

Leonard Lampe, president of the Native Village of Nuiqsut, expressed his belief of the effect of increased traffic on caribou:

> "…I feel cause of all the traffic between Fairbanks and Endicott, much more increased traffic that caribou are hesitant to cross the main roads because of all the traffic. I feel that has something to do with the caribou migration as well, because of increased traffic as well as air, not just ground, as well as air, seismic operations happening all over." (Leonard Lampe 1997 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Ice roads built and used during operations would continue to draw off water from area lakes. Water removal from lakes could potentially affect the fish populations, especially in late winter when water volumes are lowest under the ice cover and water quality and dissolved oxygen concentrations are low. Excessive water withdrawal or disturbance at this time could potentially eliminate fish populations in these lakes (Section 4A3.2), and thus affect fish availability as a subsistence resource. A Barrow resident expressed the importance of lakes to the Inupiat:

> "These deep lakes are very crucial to us. And, those are the prime targets that you are looking at for your water source. Because, in the shallow areas, the fish don't overwinter in the shallow lakes. They overwinter in the deep water, because they freeze to the bottom of the lake six to seven feet sometimes in the course of a year." (Arnold Brower Jr. 1982, National Petroleum Reserve-Alaska Scoping, Barrow)

However, no impacts to fish availability are expected if CPAI adheres to the water withdrawal permit conditions (Section 4.3.2.1).

The bridge over the Nigliq Channel and other smaller bridges would have an effect on subsistence during operation similar to that of construction (see Section 4A.3.2.1-Bridges). Pilings in the channel would have the potential to change the distribution of river sediments and debris, causing transportation problems as people in boats try to pass under the bridge while fishing in the channel or en route to other harvest locations. As shown in Figure 3.4.3.2-10, fishing effort in the Nigliq Channel sites in net-days is dramatically higher than fishing effort on the Colville River outer delta and main channel sites, further emphasizing the importance of fishing on the channel. Seals could be disturbed if they are hauled out in the area during high-traffic periods as noted in Section 4A.3.4.2. Residents are also concerned about the bridge being washed out, especially if the pipeline, as in this alternative, goes across the channel on the bridge. Isaac Nukapigak in the 2003 ASDP scoping testimony for Nuiqsut observed, "The bridge, you know, that's another thing that I, myself, also be very concerned about because that is our transportation corridor that we utilize to go out and hunt our fish and our furbearers, you know, marine mammals hunting." (2003 ASDP Nuiqsut Scoping Transcripts)

Should the channel be made non-navigable to small boats because of siltation, the difficulty of accessing resources by boat along the channel would increase. However, the USCG must approve construction and make judgments on navigability, which may result in conditions on their approval to assure such blockages do not occur. Resources that are harvested in the channel include marine mammals, waterfowl, fish, and caribou, all of which are harvested in large proportion by boat in or near the Nigliq Channel, Nigliq Delta, and Fish and Judy creeks.

Under Alternative A, a new pipeline would be in operation between CD-1 and the production pads. Pipelines would be a minimum of 5 feet above the tundra and would cross several drainages. Although caribou will cross under pipelines elevated at least 5 feet, they more readily cross under higher pipelines. Crossing of the road and pipeline combination during the winter could alter caribou movement because of reduced clearance or the creation of a visual barrier, especially along east-west oriented pipelines such as the pipeline segment between CD-5 and CD-6. Although the proposed pads and pipelines would alter caribou movement in industrial activity areas, they would not affect the overall caribou population and would result in only minor changes in herd distribution. However, at the local scale, where hunters have customary hunting areas, minor shifts in caribou availability can affect subsistence users' access to caribou. The caribou could not be where the hunter usually harvests them in the number and condition that hunters would anticipate without the industrial activity.

Interviews (SRB&A 2003a, Field Interviews), scoping comments, and public testimony (including scoping for Point Thomson, ASDP, and several hearings for National Petroleum Reserve-Alaska) have indicated that hunters believe that pipelines deflect both caribou and hunters as well as affect the direction of herd movement and size.

Subsistence users do not believe that a minimum pipeline height of 5 feet is adequate for caribou passage, unless something, such as insects or predators, is motivating the caribou. Several Nuiqsut hunters related the following scenario as evidence that pipelines deflect caribou:

> **"**Some caribou have a hard time crossing the Meltwater pipeline. Some of pipeline is too low—four to five feet; it needs to be 7 to 8 feet for caribou to get to calving grounds and the ocean where it is cooler." (SRB&A 2003a)

Pipelines hinder subsistence access in two ways: (1) subsistence users cannot cross the pipelines if snow conditions have caused the height of the pipeline to be too low and subsistence users often must follow pipelines for some distance to find adequate clearance for passage when traveling by all-terrain vehicles, snowmobiles, or boats (1997 National Petroleum Reserve-Alaska Scoping Nuiqsut);and, (2) subsistence users are reluctant to shoot around pipelines. A Nuiqsut hunter expressed the difficulty of crossing pipelines:

> "Well the recommendation from the community for outside development was either bury a good portion of the pipeline or elevate it high enough. I mean 5 feet is not adequate in the wintertime. There's no way that you can cross, even with a snowmobile. You have to follow the pipeline in order to get to an area where you can you can finally cross it. It could take you an additional 10 miles of the quickest route that you might be able to come home on, but because of the height of the pipeline and the snowdrifts, that makes it that much harder, and I do think that the caribou have that same problem as like we do." (Isaac Nukapigak 1997 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Pipelines also deter hunting because of the inherent safety concerns involved with hunting near them. One Nuiqsut resident stated,

> **"**We don't go down that way to caribou hunt because of the pipeline in there; it is a big obstruction. A lot of times they [caribou] are on the pipeline side and we don't shoot. They [industry] tell us it is okay to shoot, but common sense says not to shoot into pipeline!" (SRB&A 2003a)

The change in access caused by pipelines would result in increased effort, cost, and risks associated with traveling farther. One Nuiqsut resident referred to this effect when she said,

> "But she's suspect that if activity persists throughout the year, it will alter the hunting and game will no longer be visible and maybe may cause hunters to go much farther. This has regards to the harvest their subsistence and additional resources [and] safety of hunters when they have to go that much farther for their subsistence and additional resources. (Ruth Nukapigak 1998 National Petroleum Reserve-Alaska Scoping, Nuiqsut)"

Subsistence users carefully observe caribou reactions to pipelines, and one hunter stated, "Some [caribou] get used to pipelines, but it takes years. Shiny pipes and pipes that vibrate feel like a living thing to the caribou and it scares them." (SRB&A 2003a, Field Interviews)

Other hunters observed changes in the Nuiqsut area in response to existing development, noting that, "Most caribou don't cross Nigliq to Fish Creek anymore. There is noise, activity, traffic, and pipelines." (SRB&A 2003a, Field Interviews)

Hunters believe that caribou could also be traveling in smaller herds because of issues with crossing pipelines. One hunter observed,

> "Caribou movement patterns have changed. The herd splits along the pipeline where they used to go straight through, and they congregate in smaller groups spread further apart. Main parts of the herd split either north or south of Alpine, all trying to head toward insect relief." (SRB&A 2003a, Field Interviews)

In summary, industrial development in the Fish and Judy creeks and Colville River Delta areas would reduce the availability of and access to the area that has supported more than half of the harvest of fish, caribou, wolves, wolverines, geese, and eiders at Nuiqsut. Subsistence harvests would not be reduced to the same extent, but subsistence access would be affected as subsistence users avoid industrial areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. To avoid industrial areas, hunters would hunt elsewhere and would travel farther at greater cost and effort. Currently, harvest locations are based on local knowledge of resources and their abundance at traditional harvest areas. Moving to another area to avoid development means harvesters would more heavily use areas with presumably fewer and less densely distributed subsistence resources. These changes to subsistence use patterns would require increased investments in time, money, fuel, and equipment. It is possible that Nuiqsut hunters would not have the same rate of harvest success if access to these traditionally used areas is altered. These effects would last for the life of the applicant's proposed action (30 years); in other words, for multiple hunter generations. The key resources in this area are harvested during more than one season each year; they have been used for multiple generations; and the affected areas are used for multiple resources each year. Effects of the applicant's proposed action would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses.

ABANDONMENT AND REHABILITATION

During the dismantlement and removal phase of abandonment and rehabilitation, subsistence resources and activities will be subject to impacts similar to those incurred from construction activities, assuming gravel fill is removed. Following termination activities, subsistence resources and activities will be subject to fewer impacts. If the roads are left in place and remain serviceable, they could continue to provide access to subsistence resources. However, if local residents have come to utilize the oilfield roads to access subsistence resources and depend on oil-reliant incomes to help support subsistence harvesting and the roads are dismantled and the income lost, local residents may find it difficult to realize any improvement in subsistence harvests.

4A.4.3.2 Alternative A – Full-Field Development Scenario Impacts on Subsistence

Effects caused by the FFD scenario are analyzed in a more general way than those for the Alternative A – CPAI Development Plan because of the hypothetical nature of the scenario. This assessment addresses the potential effects to subsistence uses of 24 locations (2 processing facilities and 22 production pads). For assessment of effects to subsistence from the FFD scenario, the Plan Area is divided into groups: the Colville River Delta Facility Group, the Fish-Judy Creeks Facility Group, and the Kalikpik-Kogru Rivers Facility Group. The Alternative A FFD scenario is discussed in Section 2.4.1.2 and shown in Figure 2.4.1.2-1.

COLVILLE RIVER DELTA FACILITY GROUP

Subsistence uses are especially concentrated in the Nigliq Channel and the main Colville River channel. Forty-one % of Nuiqsut's caribou harvest came from this area (Section 3.4.3), primarily in summer. The Colville River Delta is an important fish harvest area in spring, summer, and fall, with October the primary harvest month. Seals are harvested in the Colville River Delta in spring, summer, and fall, and the area accounts for 28 % of the Nuiqsut eider harvest, 16 % of the geese harvest, and 35 % of the wolverine harvest. Several cabins and subsistence camps in the Colville River Delta (both the Nigliq and main channels) serve as a base for subsistence activities such as fishing. Subsistence user comments reflect this usage:

> **"**All the way down to the mouth of Nagaluk (ph) they put their nets. It's true that during the summer, that (Inupiaq), they put nets there, yes, but for whitefish, this is – this Nagaluk (ph) River is what they use the most. And then if they cannot do it there when the bay opens up, they go through the fish screen and use that area also for fishing. The Ublutuoch River which is really close from here and it bends like crazy like a snake, there's no fishing there. They don't fish there. It's the Fish Creek area is what they use…" (Nelson Ahvakana 1998 National Petroleum Reserve-Alaska, Nuiqsut)

Nuiqsut residents associate existing Alpine development with reduced fish harvests in the Colville River Delta. One resident said,

> **"**I pull nets for cisco in October north of Nuiqsut on the Nigliq Channel. Fishing has slowed down since Alpine went online. I don't even bother to fish much unless other people are getting a lot because the effort is not worth the gas money I have to spend." (SRB&A 2003a, Field Interviews)

Development in the Colville River Delta Facility Group area would affect current subsistence use of eider and geese, berries, seal, wolf, wolverine, fish, winter and summer caribou, and moose. The FFD of the Colville River Delta area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases.

This area also is used occasionally by residents of Barrow and Anaktuvuk Pass for the harvest of subsistence resources such as fish, caribou, wolf, and wolverine, and, consequently, subsistence of these communities could be affected, though to a much lower level than Nuiqsut's subsistence use. Anaktuvuk Pass people could fish in the Colville River Delta when visiting relatives in Nuiqsut. Several Barrow families have relatives living in Nuiqsut, and people move back and forth between the two communities. Barrow residents have ancestral ties to areas between Barrow and Nuiqsut, and Barrow residents continue to return to those areas for subsistence activities. Barrow hunters hunt in the area for caribou, moose, and furbearers, primarily wolf and wolverine, in recent times. The Colville River Delta is on the eastern edge of Barrow's subsistence-use area. There is no known current use of the Colville River Delta area by Atqasuk residents.

FISH-JUDY CREEKS FACILITY GROUP

The Fish and Judy creeks area is a heavy subsistence-use area for Nuiqsut, as noted 20 years ago in a Barrow hearing, "On your briefs, here, you have failed to point out the area of Fish Creek, one of the most important rivers that we have for the people of Nuiqsut. As a subsistence area, it is hunted and fished very heavily." (Sam Taalak 1982, National Petroleum Reserve-Alaska Testimony, Barrow)

Fishing occurs in summer and winter; caribou are harvested year-round (primarily in the summer by using boats); and the area accounts for 25 % of the Nuiqsut caribou harvest, 63 % of the geese harvest, 55 % of the wolf harvest, and 15 % of the wolverine harvest. Hunters harvest wolf and wolverine in the November-to-April time period with the use of snowmobiles. Moose hunting in August by boat and berry picking in the fall also occurs in the area. Nuiqsut residents have subsistence cabins, camp sites, drying racks, and tent platforms in this area and use the cabins and camps as a base for conducting several subsistence activities at the same time (fish and caribou in summer and fall and berry picking in the fall near camps and cabins). The camp sites and cabins are shared among family and friends, and their use is traced back several generations by family. People know and value the history of the camps and cabins, including a new structure on an old site. Hunters noted that the elders located these cabins and camps in strategic places where multiple resources are available.

Development in the Fish-Judy Creeks Facility Group area would affect current subsistence use of geese, berries, wolf, wolverine, fish, winter and summer caribou, and moose. The FFD of the Fish and Judy creeks area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases. The Fish and Judy creeks area is an important Nuiqsut subsistence-use area for key subsistence resources.

This area is also used by residents of other communities for the harvest of subsistence resources such as fish, caribou, wolf, and wolverine, though the impact to their subsistence use would be less than that for the residents of Nuiqsut. Barrow hunters occasionally use the Fish and Judy creeks area for caribou, wolf, wolverine, and fox. The hunters usually travel in winter by snowmobile and make use of cabins and camps near Teshekpuk Lake and along the Ikpikpuk and Chipp rivers as a base for snowmobile travel. Anaktuvuk Pass people also make periodic subsistence use of the Fish and Judy Creeks area. These uses are primarily associated with caribou harvest failures at Anaktuvuk Pass and when visiting relatives in Nuiqsut. To the extent that FFD affects Nuiqsut harvest patterns, it could affect sharing, trading, and gifting with Anaktuvuk Pass residents, and reduce an emergency reserve hunting option for Anaktuvuk Pass. In addition, Nuiqsut hunters could go farther south for furs and caribou, thus competing with Anaktuvuk Pass hunters, or farther west, competing with Barrow and Atqasuk hunters. Atqasuk hunters make occasional use of the Fish and Judy creeks area. This use is primarily in the winter by snowmobile for wolf and wolverine, with incidental harvest of caribou. Furbearer hunting requires a large travel and hunting area, and with development, hunters could travel farther and enter the traditional territory of other communities.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

The Kalikpik and Kogru rivers area is less important as a Nuiqsut subsistence-use area for key subsistence resources than the Colville River Delta and Fish and Judy creeks areas. However, Nuiqsut subsistence harvesters use the Kalikpik and Kogru rivers area for caribou in summer and winter if they are not found closer to the community, for geese in spring, wolf and wolverine in winter, fish, berries, and eider and seal hunting trips. There are two reported subsistence camps in the Kalikpik and Kogru rivers area. It is possible that additional camps exist in this area.

Development in the Kalikpik-Kogru Rivers Facility Group area would affect current Nuiqsut subsistence use of eiders, geese, berries, wolf, wolverine, fish, and winter and summer caribou. The FFD of the Kalikpik and Kogru rivers area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases.

The Kalikpik and Kogru rivers area is occasionally used by residents of other communities for the harvest of subsistence resources, including caribou, wolf, and wolverine. Barrow hunters occasionally use the area for caribou if they are not found closer to Barrow. The Kalikpik and Kogru rivers area is a historical subsistence-use area for several Barrow families. Atqasuk hunters occasionally use the Kalikpik and Kogru rivers area for wolf and wolverine, primarily in the winter by snowmobile. This area is “homeland” for several families. In the past, they traveled to this area in summer by boat for caribou, waterfowl, and fish. There is no known current use of the Kalikpik and Kogru rivers area by Anaktuvuk Pass residents.

4A.4.3.3 Alternative A – Summary of Impacts (CPAI and FFD) on Subsistence

Effects from construction and operation for the Alternative A (CPAI and FFD) are expected to last for the lifetime of the development and are expected to be primarily local in extent for the Alternative A – CPAI Development Plan and regional in extent for the Alternative A – Full-Field Development Scenario. Construction and operation would affect availability of key subsistence resources because of deflection or displacement of these resources from customary harvest locations. Access to subsistence resources would be affected by the perception of regulatory barriers; the reluctance to hunt and shoot firearms near industrial facilities including pipelines; raised road berms; pipelines with snowdrifts in the winter that hinder passage; and a preference for animals not habituated to industrial development. Indirect effects would include hunters who go to another area, which would result in increased effort, cost, and risks associated with traveling farther.

The FFD would affect key subsistence resources (caribou, fish, waterfowl, wolf, wolverine, and geese) and would occur in seasonal and concentrated subsistence-use areas (the Colville River Delta and the Fish and Judy creeks area) for these key subsistence resources. Nuiqsut residents, as well as residents of other North Slope communities, have harvested and used resources in these specific areas for multiple generations and currently harvest multiple resources during several seasons each year in these areas. Effects from construction and operation would occur in key geographic areas relative to other areas of subsistence availability and would pertain to Nuiqsut individual subsistence users, groups of users, and the overall pattern of community subsistence uses. Construction and operation of FFD would compound Nuiqsut resident's perceptions of being surrounded by development. Competition for key resources among Nuiqsut, Anaktuvuk Pass, Barrow, and Atqasuk would increase if Nuiqsut hunters expand from traditional subsistence-use areas close to Nuiqsut to farther outlying areas.

4A.4.3.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Subsistence

The following mitigation measures should be considered:

- To the degree possible, the pipeline should be buried to avoid creating barriers to caribou. In particular, pipeline sections should be buried between CD-2 and CD-7 to increase crossing success. (See potential mitigation measure discussion in 4A.3.4.1.)

- Where burial is not possible, pipelines should be elevated more than 5 feet (e.g., 7 feet) to allow unimpeded crossings by caribou

- Consider FFD in phases such that development of new pads would occur in concert with decommissioning of early development of CPAI.

4A.4.3.5 Alternative A – Effectiveness of Protective Measures for Subsistence

Stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding general disturbance, general damage, and the chasing of wildlife as well as the wildlife stipulations for polar bears, caribou, and birds appear to afford effective subsistence-resource protection. This EIS provides additional mitigation that would reduce impacts to caribou and hunter access, and improve coordination between the local community, agencies, and industry. The anticipated results of additional mitigation is described on the following page.

Potential Mitigation Measures	Anticipated Results
Bury pipelines	Decrease barriers and allow unimpeded crossings by caribou and hunters.
Elevate pipelines to more than 5 feet (e.g. 7 feet)	Decrease barriers and allow unimpeded crossings by caribou and hunters.
Enforce a company policy of “No Hunting and Fishing” in industrial areas by industry personnel (included in current Northeast National Petroleum Reserve-Alaska stipulations)	Decrease competition between industry personnel and local users.
Limit aircraft and road traffic in important subsistence-use areas during harvest season (included in current Northeast National Petroleum Reserve-Alaska stipulations)	Decrease disturbance of resources in harvest areas during harvest season.
Empower a committee of local subsistence users, agency personnel, and CPAI that would meet on a regular basis to exchange information, identify concerns and issues, develop research and monitoring plans, oversee research and monitoring implementation, review data, identify options to resolve issues, establish and implement plans to resolve issues, and resolve issues in a mutually satisfactory manner for all parties.	Provides a forum for CPAI, local subsistence users and agency personnel to identify and work together to resolve conflicts/issues, suggest areas of research and monitoring, and disseminate project development information to communities.
Enforce/Implement stipulations. Stipulations are in place to protect subsistence resources and harvests in National Petroleum Reserve-Alaska. Similar stipulations should be enforced/implemented for development areas east of the National Petroleum Reserve-Alaska boundary.	Protect subsistence resources and harvests. It is not clear if current National Petroleum Reserve-Alaska stipulations have had a beneficial impact on resources and harvests.
Enforcement officer based in Nuiqsut to address violations of stipulations and other issues.	Consistently address issues between industry and local residents as they occur (e.g., damage of caches on allotments and at camps by rolligons)

4A.4.4 Environmental Justice

Evaluation of the demographic characteristics of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut in Section 3.4.4 found that the populations of each of these communities qualified as minority populations and require evaluation for disproportionate impacts.

Disproportionate impacts under the guidelines for environmental justice evaluations are circumstances where direct and indirect project impacts could affect minority or low-income population groups to a greater extent than the general population. If such disproportionate impacts are found to occur, then mitigation measures are identified that reduce, avoid, or eliminate these impacts.

The evaluation of disproportionate impacts normally occurs in a circumstance where a number of diverse population groups could be impacted by a proposed project that is in or near a major urban center. The evaluation seeks to determine if the minority or low-income groups among all of the affected groups are affected to a greater degree. In this case, potentially affected North Slope residents live in communities that are from 57 to 94 % minority. Thus, impacts caused by the Alternative A – CPAI Development Plan or the Alternative A – Full-Field Development Scenario that are likely to impact residents in the Plan Area are also likely to be disproportionate impacts under Environmental Justice criteria. This does not mean all project impacts are disproportionate impacts; only those that would directly or indirectly affect North Slope residents would be considered disproportionate impacts.

4A.4.4.1 Alternative A – Disproportionate Impacts (CPAI and FFD) on Environmental Justice

The impacts identified in each resource area have been reviewed to determine if they are also “disproportionate impacts” to local residents, especially in Nuiqsut. These impacts have been listed in Table 4A.4.4-1 “Alternative A – Potential Disproportionate Impacts.” Within this table, both direct and indirect impacts were identified using the following criteria:

- Direct Impacts—have a direct impact on identified minority or low-income populations; impacts would be expected to directly affect the health, welfare, and cultural stability of the affected population. An example would be contamination of a resource such as water used directly by the affected population.
- Indirect Impacts—impacts on the viability or availability of resources essential for daily use of minority or low-income populations. As example might be environmental contamination that causes increased disease or contamination of fish or animals used in the daily diet. The contamination is an indirect impact.

Impacts to resources that do not have a direct or indirect link as described above are noted as “none identified” in Table 4A.4.4-1.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Spills	Spills could impact water quality and wildlife affecting subsistence harvest.	Spills could impact water quality and wildlife affecting subsistence harvest. Concerns about contaminants could restrict consumption of subsistence foods.	Same as Alternative A-CPAI	See Section 4.3: Spill prevention, detection, and cleanup measures.
Physical				
Terrestrial	None Identified	None Identified		
Aquatic	None Identified	To the extent that impacts to water quality during construction could impact water quality subsistence resources and subsistence harvest could be impacted.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.2.2: Proper disposal of wastes. Facility design to minimize erosion. Construction during winter. BMPs during construction and operation.
Atmospheric/ Environmental	Potential increase in PM emissions; if concentrations in Nuiqsut increase potential health impacts, such as increased asthma rates may result.	To the extent that aircraft noise deflects subsistence resources, subsistence harvest activities could be disrupted.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.2.3,: Continue monitoring at Nuiqsut. Avoid aircraft operations near subsistence harvest activities.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Biological				
Terrestrial Vegetation & Wetland	None Identified	To the extent that impacts to wetlands affect subsistence resources, impacts to subsistence harvest could result.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.1,: Minimize disturbance to wetlands and permafrost.
Fish	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected.	Same potential impacts as Alternative A-CPAI**;** increased potential due to larger development area.	See Section 4A.3.3: Avoid impacts to surface water bodies. Develop gravel extraction sites to avoid fish over-wintering and spawning areas. Design standards for river/stream crossings. Proper scheduling and control of water withdrawals.
Birds	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest. (See discussion 4A.3.4)	Same potential impacts as Alternative A-CPAI**;** increased potential due to larger development area.	See Section 4A.3.4: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.
Spills	Spills could impact water quality and wildlife affecting subsistence harvest.	Spills could impact water quality and wildlife affecting subsistence harvest.	Same as Alternative A-CPAI	See Section 4.4.5: Spill prevention, detection, and cleanup measures.
Mammals	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest. (See discussion 4A.3.5)	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.4.5: Measures to protect predators. Design criteria to minimize impacts on herbivore movement in the Plan Area. Selective controls on the movement of vehicles.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Threatened and Endangered Species	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest.	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.6: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.
Social				
Socio-Cultural	To the extent that income benefits accrue to local residents, expendable income is increased.	Increased income and stress of reduced subsistence hunting/fishing may correspond with increased rates of alcoholism, smoking, and drug abuse, which in turn increases domestic violence, cancer, asthma, and Fetal Alcohol Syndrome	Same as those identified under Alternative A - CPAI	See Subsistence Harvest and Use below.
Regional Economy	Revenues from oil production to NSB and village corporations.	None identified	Same as those identified under Alternative A - CPAI	Mitigation not required
Subsistence Harvest and Use	Displacement and avoidance of subsistence resources could affect subsistence harvest.	Impacts to subsistence harvest could affect community social organization, health, and welfare. Shifts in diet to foods with lower nutritional value instead of subsistence foods could result in increased rates of cancer and diabetes.	Same as those identified under Alternative A - CPAI	See Section 4A.4.3; Prohibit company workers from hunting/fishing in Plan Area.
Cultural Resources	None identified	Loss of cultural resources from construction could impact maintenance of cultural traditions.	Same as those identified under Alternative A - CPAI	See Section 4A.4.5; Maintain buffers around known resource sites. Review ice road routes prior to use.
Land Uses and Coastal Zone	None identified	None identified		
Recreation	None identified	None identified		
Visual	None identified	None identified		
Transportation	None identified	None identified		

4A.4.4.2 Alternative A – Summary of Impacts (CPAI and FFD) on Environmental Justice

Table 4A.4.4-1 shows direct and indirect impacts under the Alternative A – CPAI Development Plan and impacts under the Alternative A – Full-Field Development Scenario. The most prevalent impacts found are the potential direct and indirect impacts related to subsistence harvest and use. Other impacts identified as potentially disproportionate include spill impacts, potential water quality, air quality, and aircraft noise impacts.

Impacts to subsistence harvest and use would arise from impacts to the availability of subsistence species in traditional use areas or a decrease in subsistence hunting success. The reduction in subsistence hunting success in turn reduces the availability of Native foods to the community. Since the Native community is the only community that depends to a significant degree on Native foods, this impact, to the extent that it occurs, falls disproportionately on the Native population. Also, as discussed in Section 4A.4.3, displacement of subsistence hunters from traditional subsistence-use areas by oil industry facilities also means greater time spent traveling longer distances to other subsistence-use areas. It could also mean that local hunters from Nuiqsut could come in competition with hunters from other villages when they use the same traditional subsistence-use areas.

The analysis of spill impacts shows that very small and small spills are unlikely to have long term, extensive impacts that would affect water quality, habitat, or subsistence species. Larger spills that are more likely to have impacts that are more extensive have a very low probability of occurrence. Spill impacts, to the extent that they occur, would be episodic, not continuous. Local residents have shown a propensity to avoid resources from areas where spills have occurred because of a lack of confidence that subsistence resources have not been contaminated. This lack of confidence could affect subsistence use for a period beyond the time when any resources affected from spills would actually persist.

As discussed in the water quality section (see Section 4A.2.2), impacts to water quality can occur as a result of spills or construction-induced erosion.

Air quality in Nuiqsut already meets national ambient air quality standards for all criteria pollutants. Short-term episodes of elevated particulate concentrations have been observed at Nuiqsut and are caused by wind-borne dust. Emissions from natural gas flaring (incidental) and equipment operation are not expected to contribute to the chronic exposure of local residents to particulate.

Low-level aircraft noise is expected to be limited to areas surrounding facility airstrips. However, helicopter operations, which are typically at lower altitudes, can range over a larger area as these aircraft move between different facility locations. Subsistence hunters have reported the interruption of hunts in progress by low-flying aircraft, especially helicopters.

ABANDONMENT AND REHABILITATION

Activities associated with dismantling and removing the satellites may disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and potential impacts to water and air quality, and noise. Once abandonment and rehabilitation are completed, Nuiqsut residents may be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Local residents may benefit from a reduction in impacts on subsistence resources compared to impacts during construction and operation.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR ENVIRONMENTAL JUSTICE

Table 4A.4.4-2 summarizes direct and indirect impacts, and descriptions of potential mitigation measures that have been identified for each resource with potentially disproportionate impacts. Table 4A.4.4.2 summarizes project features, procedures, and descriptions of potential mitigation measures that have been identified to reduce impacts for each resource with potentially disproportionate impacts. It should be noted that the impacts identified for minority and low-income populations do not consider the application of potential mitigation; thus, the residual impacts that would occur after mitigation have not been quantified. To the extent that the application of the identified potential mitigation measures do not reduce or avoid the impacts identified, some disproportionate impacts to minority and low-income populations would occur.

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS

Resource Category	Project Features, Procedures, and Mitigation	Description
Spills	See Section 4.3.5: Spill prevention, detection, and cleanup measures.	Measures to prevent spills shall be incorporated into the design and operation/maintenance procedures for the oilfield. Vertical loops in produced fluids pipelines or automatic shutdown isolation valves in seawater and diesel pipelines shall be installed on each side of major creek or river crossings to minimize the amount of spilled material that might enter these rivers. Frequent visual inspection of pipelines on the Nigliq Channel bridge shall be performed during break-up floods. Long-term monitoring of impacts and the recovery process shall be conducted for each spill that reaches tundra or water bodies.
Physical		
Terrestrial	None Identified	
Aquatic	See Section 4A.2.2: Proper disposal of wastes. Facility design to minimize erosion. Construction during winter. BMPs during construction and operation.	Proper waste disposal methods shall be incorporated into the operation procedures for the oilfield. Gravel structures shall be designed to withstand flooding. Adequately sized culverts and bridges shall be installed to allow water flow though at rates sufficient to minimize erosion. Construction shall be conducted in the winter when surface water is frozen. BMPs will be developed, documented, and followed during construction and operation to minimize impacts.
Atmospheric/ Environmental	See Section 4A.2.3,: Continue monitoring at Nuiqsut. Avoid aircraft operations near subsistence harvest activities.	Collection of air quality data at Nuiqsut shall continue to monitor for deterioration of the ambient air quality. Aircraft flights shall be avoided, when possible, near subsistence harvest activities.
Biological		
Terrestrial Vegetation and Wetland	See Section 4A.3.1,: Minimize disturbance to wetlands and permafrost.	Slopes would be stabilized to reduce erosion where necessary. Dust impacts would be reduced by applying sealing agents, chip seal, or water to dust prone areas. Ice roads shall be routed as directly as possible but shall avoid shrub areas. Off-road tundra travel shall be restricted by limiting the number of vehicle passes in an area, avoiding tight turns, and using only approved low-pressure vehicles.

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	Project Features, Procedures, and Mitigation	Description
Fish	See Section 4A.3.2: Avoid impacts to surface water bodies. Develop gravel extraction sites to avoid fish overwintering and spawning areas. Design standards for river/stream crossings. Proper scheduling and control of water withdrawals.	Silt fencing shall be installed and maintained where silt may enter a water body. After project completion, gravel mines shall be converted to fish habitat, if practicable. Bridges shall be constructed to span the rivers' main channels and floodplain terraces, if possible. Culverts shall be installed in roads and bridge approaches to ensure natural hydrological regimes are maintained. Water withdrawals from lakes shall be limited in volume and monitoring of permitted lake water quality will be conducted.
Birds	See Section 4A.3.3: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.	Traffic speeds on roads shall be reduced during brood rearing. Traffic levels shall be reduced by limited field access to necessary industry personnel only. Waterfowl and seabirds shall be hazed away from active airstrips to prevent collisions with aircraft and reduce mortality impacts.
Mammals	See Section 4A.3.4: Hunting control measures to protect predators. Design criteria to minimize impacts on herbivore movement in the Plan Area. Selective controls on the movement of vehicles.	Hunting activities in the Plan Area would be coordinated among the NSB, State of Alaska, and federal agencies. Pipelines shall be designed to allow caribou passage. Roads and pipelines shall be separated by more than 300 feet where possible. Vehicle traffic and aircraft flights shall be restricted, particularly during calving periods.
Threatened & Endangered Species	See Section 4A.3.5: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.	Aircraft altitude restrictions over the nearshore Beaufort Sea could be implemented to minimize disturbance to migrating Bowhead whales. Traffic speeds on roads shall be reduced during brood rearing. Spectacle eiders shall be hazed away from active airstrips to prevent collisions with aircraft.
Socio-Cultural	See Subsistence Harvest and Use below.	
Regional Economy	Mitigation not required	

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	Project Features, Procedures, and Mitigation	Description
Subsistence Harvest and Use	See Section 4A.4.3; Establish community, industry, agency coordination group to identify address specific project subsistence effects.	Pipelines shall be designed to allow caribou passage. Aircraft flights shall be avoided, when possible, near subsistence harvest activities. Industry shall conduct community outreach programs to address user concerns, identify topics for research, and review possible solutions for implementation.
Cultural Resources	See Section 4A.4.5; Maintain buffers around known resource sites. Review ice road routes prior to use.	Route surveys will be conducted to identify and avoid known or possible cultural resources prior to construction. Industry shall coordinate with SHPO on plans for addressing inadvertent damage, vandalism, spills, and site monitoring. If sites are discovered during construction or operations, activity shall stop until SHPO is consulted and evaluation of the resource is completed.
Land Uses and Coastal Zone	None Identified	
Recreation	None Identified	
Visual	None Identified	
Transportation	None Identified	

4A.4.4.3 Alternative A – Effectiveness of Protective Measures for Environmental Justice

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to environmental justice. Mitigation measures and stipulations that reduce impacts to resources depended upon for the local lifestyle also reduce the disproportionate impacts to the local community.

4A.4.5 Cultural Resources

This section discusses locations of cultural resources in relation to Alternative A facilities and actions and the direct and indirect impacts to the resources likely to be affected by the construction and operation of the proposed project alternative. Direct effects to cultural resources are impacts that occur at the same time and place (40 CFR 1508.8) and are predicated on changes to the characteristics of a cultural property (e.g., integrity and association) (36 CFR Part 800.5). Indirect effects on cultural resources could include increased access to and close proximity of project components to culturally sensitive areas. Under Alternative A, known cultural resources are within 1 mile of various components.

4A.4.5.1 Alternative A – CPAI Development Plan Impacts on Cultural Resources

Construction and operation of the Alternative A – CPAI Development Plan would occur in the vicinity of known cultural resources. For proposed satellite site CD-3, the nearest cultural resource is HAR-052 (Table 3.4.5-2), which contains a tent ring or sod house foundation and is approximately 1 mile east of the production pad and approximately 1/2 mile east of the proposed airstrip. Construction and operation of the proposed CD-3 production pad would have negligible direct and indirect effects on known cultural resources.

In the surrounding area of proposed pad CD-4, according to NSB TLUI data, one documented cultural resource from the first half of the twentieth century, TLUIHAR-083 (HAR-156) (see Table 3.4.5-2), is less than 1/4 mile (approximately 625 feet) west of the proposed rights-of-way (ROW). However, the AHRS states that this site is located approximately 1/2 mile west of the proposed ROW; thus, the nearest cultural resource to CD-4 is TLUIHAR-082 (Table 3.4.5-2), which is currently not described and is less than 1/4 mile (approximately 1,100 feet) from the production pad. Direct effects to known cultural resources could include damage to or destruction of the resource during construction of the proposed production pad. Indirect effects could include damage to the resource caused by erosion, traffic, or looting. The integrity of unknown subsurface, surface, and aboveground cultural resources could be significantly affected by construction activities**,** though these impacts could be avoided through consultation as required under Section 106 of the NHPA.

As yet undescribed TLUIHAR-087 (Table 3.4.5-2) is less than 1 mile north of the proposed pipeline ROW constructed between CD-6 and CD-5. No documented cultural resources are in the immediate vicinity of this alternative's pads, roads, and pipelines west of the Nigliq Channel. The applicant's proposed action west of the channel could have negligible direct or indirect effects on known cultural resources.

The nearest documented cultural resource to the ASRC Mine Site is HAR-055, which is less than 1/4 mile northwest of the gravel mine. There are no documented cultural resources in the vicinity of Clover. No direct or indirect effect on known cultural resources would occur from the construction and operation of the existing ASRC Mine site or Clover. However, the construction of these gravel mines would involve significant ground-disturbing activities, which could affect unknown surface and subsurface cultural resources. As described in Section 2, ice roads and pads would be developed for transporting gravel from the gravel mines to the production pads**,** as well as in support of construction, drilling, and operations at CD-3. These ice roads could affect unknown surface or aboveground cultural resources. Prior to construction, CPAI may be required to perform an evaluation and assessment of possible cultural resources in the immediate areas of the proposed ice roads.

ABANDONMENT AND REHABILITATION

It is unlikely that cultural resources would be impacted by abandonment activities.

4A.4.5.2 Alternative A – Full-Field Development Scenario Impacts on Cultural Resources

Impacts to cultural resources also could occur under FFD, which includes 22 hypothetical production pads and 2 hypothetical processing facilities in addition to the 5 pads proposed under the Alternative A – CPAI Development Plan.

The locations of a hypothetical pad, pad footprint, roads, airstrips, ROWs, or pipeline within 1/4 mile of a cultural resource could result in direct and indirect effects to cultural resources. Impacts resulting from construction and operation of these FFD facilities could include damage to or destruction of the resource during construction or damage to the resource caused by erosion, traffic, or looting. Ground disturbing activities would be monitored or cleared for cultural resources prior to development. Impacts to cultural resources for FFD are discussed by facility groups of the Plan Area in the following sections.

COLVILLE RIVER DELTA FACILITY GROUP

There are nine known cultural resource sites in this facility group. These resources could be affected if proposed facilities were constructed in these locations. For example, if hypothetical production pad HP-14 were placed over HAR-008 and HAR-160, which are in the area designated for HP-14, the cultural value of these two sites could be destroyed. Similarly, there is one cultural resource TLUI-86 in the area identified for proposed HP-13, two cultural resource sites (TLUIHAR-084 [HAR-169] and HAR-054) in the area identified for proposed HP-5, and four documented cultural resources (TLUIHAR-077, TLUIHAR-079, HAR-158 and TLUI-61) in the area identified for proposed HP-8. These sites and other cultural sites in the facility group, however, are small and, through Section 106 consultation, it is anticipated that construction impacts could be avoided. No documented cultural resources are in the immediate vicinity of the HP-4, HP-7, and HP-12 production pads.

FISH-JUDY CREEKS FACILITY GROUP

There are seven known cultural resource sites in this facility group. These resources could be affected if proposed facilities were constructed in these locations. There is one cultural resource, HAR-044, in the area identified for proposed HP-3, one cultural resource (TLUI-54) in the area identified for proposed HP-1, one cultural resource (TLUI-78) in the area identified for proposed HP-2, and four cultural resources (HAR-038, HAR-39, HAR-053, and TLUIHAR-041) in the area identified for the proposed HPF-1 processing facility. In addition, the HP-11 hypothetical production pad, northwest of Ocean Point, lies in an area of the Colville River Delta that contains many cultural resources and paleontological sites. No documented cultural resources are in the immediate vicinity of the HP-6, HP-9, HP-10, HP-11, HP-15, HP-16, HP-17, and HP-19 production pads. Through Section 106 consultation, it is anticipated that construction impacts could be avoided to cultural resource sites.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

There are 10 known cultural resource sites in the Kalikpik-Kogru Rivers Facility Group. These resources could be affected if proposed facilities were constructed in these locations. There are six cultural resources (HAR-002, HAR-014, HAR-025, TLUIHAR-059, TLUIHAR-060, and TLUIHAR-061 [HAR-007]) in the area identified for proposed HP-22, one cultural resource (TLUIHAR-062) identified in the area approximately 3/4 mile from the proposed pipeline/road ROW between HP-21 and HP-22, and three cultural resources (HAR-009, HAR-048, and HAR-049) within 1 mile of the proposed pipeline/road ROW between HP-20 and HPF-2. Through Section 106 consultation, it is anticipated that construction and operation impacts would be avoided. No documented cultural resources are in the immediate vicinity of the proposed HP-18, HP-20, and HP-21 production pads and the HPF-2 processing facility.

4A.4.5.3 Alternative A – Summary of Impacts (CPAI and FFD) on Cultural Resources

Under the Alternative A – CPAI Development Plan, cultural resources are situated in the vicinity of the production pads, the road/pipeline ROW, and the ASRC Mine Site. Under the Alternative A – Full-Field Development Scenario, cultural resources are located in each of the three facility groups and the ROWs. Any project facility or pad within 1/4 mile of a cultural resource could result in direct effects including damage to or destruction of the resource during construction of the proposed well pad**,** though construction impacts—at least to known cultural resources—could be avoided through Section 106 consultation.

Under the Alternative A – CPAI Development Plan, one cultural resource (TLUIHAR-082) is less than 1/4 mile from the CD-4 production pad, and one cultural resource (HAR-055) is less than 1/4 mile from the ASRC Mine Site.

Under FFD, cultural resources are within the affected areas of production pads (HP-5, HP-8, HP-13, and HP-14) and ROWs (HP-8 to HP-6) in the Colville River Delta Facility group; production pads (HP-1, HP-2, HP-3 and HP-11) and the processing facility (HPF-1) in the Fish-Judy Creeks Facility Group; and a production pad (HP-22) and ROWs (HP-21 to HP-22 and HP-20 to HPF-2) in the Kalikpik-Kogru Rivers Facility Group. The HP-8 to HP-6 ROW extends through the village of Nuiqsut (TLUI-61), and one cultural resource (TLUIHAR-062) is less than 1/4 mile from the HP-21 to HP-22 ROW.

Indirect effects could include damage to the resource caused by inadvertent oil spills, subsequent cleanup activities, or looting. The integrity of subsurface, surface, and aboveground cultural resources could be significantly affected by construction activities. Unknown or undocumented cultural resources could be situated in the proposed ROWs or footprints of Alternative A CPAI and FFD components. However, ground disturbing activities would be monitored or cleared for cultural resources prior to development.

4A.4.5.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Cultural Resources

Prior to construction of ice roads, CPAI would perform an evaluation and assessment of possible cultural resources in the immediate areas of the proposed ice roads.

CPAI would coordinate with SHPO to provide a cultural resources management plan for the sites less than 1/4 mile from components of the applicant's proposed action to address the issue of potential site damage as a result of development activities, including inadvertent damage, vandalism, spills, and site monitoring.

If cultural resources are discovered as a result of construction, development, or operation activities under the applicant's proposed action, activity would be stopped until the SHPO is consulted and an evaluation of the resource can be completed.

4A.4.5.5 Alternative A – Effectiveness of Protective Measures for Cultural Resources

Stipulation 74 of the Northeast National Petroleum Reserve-Alaska IAP/EIS requires surveys for cultural and paleontological resources prior to any ground disturbing activities. This will insure that any resources are noted and appropriate measures taken for avoidance or collection occur. This EIS has identified potential mitigation that would insure coordination and planning between the SHPO and the applicant on known sites close to development operations.

4A.4.6 Land Uses and Coastal Management

4A.4.6.1 Alternative A – CPAI Development Plan Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

Under Alternative A, development of the proposed facilities for the Plan Area would occur on lands owned by the federal government, the state, and Kuukpik Corporation. Implementation of the ASDP under Alternative A would not change ownership status on lands within the Plan Area, but would occur under negotiated leases.

As described in Section 3, most of the Plan Area is currently undeveloped with the exception of the existing Alpine Field oil production pads and the village of Nuiqsut. With the exception of the Alpine Field development, oil development is concentrated to the east of the Plan Area and to the northeast of the village of Nuiqsut. Development under Alternative A would represent an increase in the total area developed within the Plan Area. The Alternative A – CPAI Development Plan calls for development of approximately 241 acres, including production pads, roads, airstrips, and 35.6 miles of pipelines. This would result in an increase of 2.4 times the total number of acres currently developed for oil production activities within the Plan Area.

The BLM established various Special Areas, SMZs, and LUEAs within the National Petroleum Reserve-Alaska to provide additional protections to various subsistence, recreational, ecological, historic, and scenic resources. SMZs and LUEAs are not legislative designations and carry no regulatory authority. Special Areas, however, do carry legislative designations and development in these areas would require special attention to design to maximize protection of the natural habitat.

Under Alternative A, Clover and CD-7, with its associated facilities, are located within the Colville River Special Area. CD-6 and its associated access roads and pipelines, would be constructed within the resource protection setback around Fish Creek (Fish Creek LUEA). The BLM stipulations state that no permanent oil and gas surface facilities are allowed within the Fish Creek setback area, except for essential transportation crossings. The potential impacts to fish resources and subsistence activities from construction of oil and gas facilities at CD-6 and CD-7 are discussed in detail in Sections 4A.3.2 and 4A.4.3, respectively. Construction of CD-6 would require that CPAI obtain an exception to the no permanent oil and gas facilities restriction in this area. Construction of the road access between the oil facilities in the National Petroleum Reserve-Alaska would also require an exception from the BLM stipulations.

Development of facilities within the CRSA must provide for maximum protection of the surface resources in this area, consistent with the purpose of the National Petroleum Reserve-Alaska, which calls for oil exploration and production. In keeping with this intent, this development proposal includes a number of design and construction measures intended to reduce the potential for adverse effects to natural resources in the area, while allowing for economically feasible development of the oil resources in the area. These measures include BLM stipulations (Appendix D) with the exceptions noted above, and other specific procedures of the applicant's proposed action, as described in Section 2. No other Special Areas or LUEAs would be directly affected under Alternative A.

Development of the proposed roads and airstrip would provide more access to these developed areas, particularly during summer months. Access would be restricted to oil industry personnel, contractors, agency personnel, and local residents. Adverse effects to subsistence and recreation would occur due to habitat alterations and the increased access, activity, and noise in the developed areas. Effects to subsistence and recreation are discussed further in Sections 4.A.4.3 and 4.A.4.7. Other permitted uses within the Plan Area, such as scientific studies, communications and navigation-related uses, and overland re-supply transport between villages, are not expected to be affected by the proposed development.

COASTAL MANAGEMENT

Development proposed under Alternative A includes construction and operation of five satellite production pads, as well as roadways, pipelines, and an airstrip. Although some of these facilities would be on federal lands that are excluded from the coastal zone under the CZMA, CPAI also proposes development on state and Kuukpik lands that are within the coastal zone. Because development on federal lands must comply with state coastal programs to the extent possible, this section evaluates all of the proposed development against the state and local district coastal zone standards, regardless of whether or not the development occurs on federal lands. Standards of the ACMP include statewide standards found in regulation (6 AAC 80.040 – 6 AAC 80.150) and the enforceable policies of the affected coastal district, the NSB.

ALASKA COASTAL MANAGEMENT PROGRAM

The ACMP provides standards and guidance for development occurring within the coastal zone to achieve a balance between development and the protection of valuable coastal resources. The state requirements in 6 AAC 80 address, but are not limited to, coastal development, recreation, development of energy facilities, transportation and utility routes, mining and mineral processing, habitats, preservation of historical resources, air and water quality, and solid waste disposal. Conformance to the coastal standards is typically achieved through construction and design measures, as well as the imposition of BLM stipulation measures for development on federal lands and alternative state required measures for development that occurs on lands not managed by BLM.

Coastal Development (6 AAC 80.040)

The coastal development standard requires that water-dependent uses or water-related uses have priority within coastal areas. Activities and uses that are not water-dependent or water-related are only permitted if no feasible and prudent inland alternatives exist.

The areas identified for development on federal lands within the National Petroleum Reserve-Alaska have been set back from the coast both to maximize oil development and to minimize effects on coastal resources. Setbacks and buffers have also been established along important river and lake habitats within the area. One production pad (CD-6) with associated roadway and pipeline is proposed within the setback area around Fish Creek. These facilities and other facilities located within 500 feet of some other water bodies would require exceptions from BLM's stipulations described in Appendix D. This alternative would also require an exception to the stipulation that prohibits road access between separate oilfields. CD-7 and some of its associated facilities are located within the CRSA within National Petroleum Reserve-Alaska. This area is designated as a special area to provide maximum protection of natural resources within the area, consistent with the purpose of National Petroleum Reserve-Alaska to provide oil and gas resources. Facilities to be developed on lands that are not managed by BLM would include three production pads, a roadway (including bridges), pipelines, and an airstrip. These facilities would mostly lie within the Colville River Delta.

Although oil production pads and their support infrastructure are not water-dependent or water-related, oil development must occur where the oil resources exist. To access these resources, production pads must be constructed near the resource and transportation facilities must be constructed to transport the oil resource to national markets. Because the oil production and transportation facilities must be located in proximity to the oil resource, there is no feasible or prudent inland alternative to development of oil production and transport facilities within this coastal area. The CPAI-proposed production pads have been designed to minimize potential effects to coastal resources, and development of access roads would be limited in the area closest to the coast (CD-3).

Development under this alternative would require BLM to grant exceptions to three stipulations: the stipulation restricting access between separate oilfields in National Petroleum Reserve-Alaska (stipulation 48); the stipulation restricting permanent oil facilities in the Fish Creek setback area (stipulation 39), and the stipulation restricting permanent facilities within 500 feet of other water bodies (stipulation 41). All other BLM stipulations and alternative measures potentially required by the state will be complied with, including stipulations requiring continued access to the coastal resources used for subsistence and for other traditional land uses. With these stipulations, the development of the proposed facilities is not expected to displace other important coastal uses and is expected to conform with the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

The Geophysical Hazard Areas consistency standard requires that districts and state agencies identify any known geophysical hazard areas and that any proposed developments in these areas incorporate measures to minimize property damage and protect against loss of life.

Possible geophysical hazards within the Plan Area include permafrost, floods, ice gouging, and earthquakes. The facilities proposed under Alternative A specifically address the geophysical hazards identified in the Plan Area. Roads and pipelines were situated to take advantage of ridges to reduce flood hazards where possible. Road, bridge, and pipeline designs have incorporated measures to maintain the permafrost and natural drainage patterns and to protect the built structures from flood events, scour, ice jams, and storm surges. These measures are expected to adequately mitigate the geophysical hazards likely to be encountered in the area and to conform with the coastal geophysical standard.

Recreation (6 AAC 80.060)

The statewide recreation standard requires that coastal districts designate areas for recreation use if (1) the area receives significant use by persons engaging in recreational pursuits or is a major tourist destination, or (2) the area has potential for high-quality recreational use because of physical, biological, or cultural features. The standard also requires that districts and state agencies give priority to maintaining and, where appropriate, increasing public access to coastal water.

The Plan Area is in a remote part of the state and is not a major tourist destination. There are, however, some recreational uses of the area and there could be some local adverse effects on recreation as discussed in more detail in Section 4A.4.7, Recreation Resources. Development proposed under Alternative A of the ASDP would be consistent with National Petroleum Reserve-Alaska stipulations requiring continued access to coastal resources for subsistence and other traditional land uses. These stipulations and alternative measures potentially required by the state should reduce any potential conflicts between the proposed development and other public uses of coastal resources.

Energy Facilities (6 AAC 80.070)

The ACMP states that the siting and approval of major energy facilities must be based, to the extent feasible and prudent, on 16 criteria within the energy facilities standard. These criteria primarily relate to reducing the potential for adverse effects to environmental and social resources. For example, the criteria stipulate that facilities minimize the probability of spills along shipping routes to protect important fishery, marine mammal, and waterfowl habitats from contamination. Another criteria calls for facility design to allow free passage and movement of fish and wildlife, with due consideration of historic migratory patterns. The criteria also call for protection of scenic, recreational, and cultural values. The state criteria also address consolidation of facilities.

The ASDP under Alternative A is consistent with the criteria in the energy standard in that facilities would be consolidated to the greatest extent possible, facilities would be sited and designed to minimize the potential to affect environmental resources, and the oil would be transported to Valdez by pipeline, the safest mode for transporting oil, reducing the potential for contamination of valuable coastal habitats. The proposed development calls for housing of all personnel to be at the existing Alpine housing facility except during drilling and construction, when personnel would be housed in temporary camps. Consolidation of facilities is also addressed in the collocation of pipelines, roads, and power lines. Roads, pipelines, and other facilities would maintain existing drainage patterns and would minimize effects on wildlife habitat and migration routes. Development of the proposed facilities would affect some wetlands and other high-value habitats, but the facilities have been sited and designed to reduce the impact to these resources to the extent possible. Although exceptions would be required for development proposed within the Fish Creek setback area, within 500 feet of other water bodies, and for the road system connection between separate oilfields, the proposed development would conform with all of the other BLM stipulations, and alternative measures potentially required by the state, designed to protect wildlife, scenic, recreational, and cultural resources.

Transportation and Utilities (6 AAC 80.080)

The Transportation and Utilities statewide standard requires that all transportation and utility routes and facilities must be sited, designed, and constructed to comply with district programs. The standard also states that they must be situated inland from beaches and shorelines unless the route or facility is water-dependent or no feasible or prudent inland alternative exists to meet the need for the route or facility.

The development proposed under Alternative A includes roadways connecting most production sites to the processing facility at CD-1, as well as pipelines from the production satellites to the processing facility. Where possible, the roads and pipelines would be co-located. Utilities would be consolidated onto the pipelines to the greatest extent possible, including electric power, fuel, water, and produced products. The road and pipeline to the CD-4 production satellite would follow the route of the existing oil product pipeline that connects the existing Alpine Facility to the pipelines at Kuparuk. The roads, bridges, and pipelines have been designed and sited to minimize potential adverse effects to coastal resources to the extent feasible. These facilities are located inland from the coast, but do cross wetlands and creeks within the Plan Area. The production satellite proposed within the lower Colville River Delta would be accessed by air to avoid road construction within the lower delta.

This alternative requires exceptions from three existing BLM stipulations as described above. Given the requirements of law, regulation, and leases, including alternative measures potentially required by the state, the design measures proposed, and project specific procedures described in Section 2, as well as the lack of road options that would not affect water bodies and wetlands, it is expected that Alternative A would comply with the transportation and utilities standard.

Mining and Mineral Processing (6 AAC 80.110)

The ACMP standards for mining and mineral processing require these activities to be designed and conducted in a manner compatible with the other coastal standards, as well as adjacent uses and activities (6 AAC 80.110 [a]). The ACMP standards also restrict extraction of sand and gravel from coastal waters, intertidal areas, barrier islands, and spits, unless no feasible and prudent alternative to coastal extraction exists that would meet public need for the sand and gravel (6 AAC 80.110 [b]).

Mining and extraction of sand and gravel is essential for development of oil production and transportation infrastructure within the ASDP Area. As stated in Section 2.4.1, Alternative A proposes extraction of gravel for use during construction and development of the proposed facilities, including gravel roads connecting many of the facilities, gravel production pads, and a gravel airstrip. Gravel sources for the development proposed under Alternative A include the currently permitted ASRC Mine Site and potentially a new site, the Clover Potential Gravel Source, on the western edge of the Colville River Delta Facility Group, southwest of the proposed CD-4 production pad. Clover is located within the Colville River Special Area, and would be required to be developed and operated in a manner that provides maximum protection for surface resources in that area, while allowing for oil resource development. All access to the site and staging areas will be constructed as ice roads and pads, reducing potential impacts to natural resources in the area. BLM stipulations regarding gravel mining and alternative measures potentially required by the state, are designed to maximize feasible protection of surface resources. Importing gravel from outside the North Slope for development activities in this area would not be economically feasible.

The gravel sites used have, or would be required to have, operating permits and reclamation plans (Appendix O) that require gravel extraction to be conducted in a manner consistent with the other state standards for protection of coastal resources. Thus, gravel mining operations permits provide for an additional review of potential mitigation measures and stipulations so that impacts are mitigated to the greatest extent feasible. Based on these requirements, it is anticipated that Alternative A will comply with the coastal standard for mining and mineral processing.

Subsistence (6 AAC 80.120)

Under the subsistence standard, state agencies and districts, in conjunction with Native corporations and any other persons or groups, could designate areas as subsistence zones in which subsistence uses and activities have priority over all non-subsistence uses and activities. Before any potentially conflicting activity could be authorized within these designated areas, a study of the possible adverse on subsistence usage must be conducted and appropriate safeguards to assure subsistence usage must be provided (6 AAC 80.120 [d]).

Alternative A would include construction of roads and bridges connecting the proposed satellites to the existing Alpine facilities. Construction of these roads could provide more efficient access to subsistence hunting and/or fishing sites, but the increased development in the area is likely to adversely affect subsistence resources through changes to habitat use and resource abundance resulting from increased foot and vehicular traffic in developed areas. In addition, subsistence activities could require increased efforts due to changes in the abundance of resources or in the areas that would be used for harvesting resources. The potential for impacts to subsistence from the proposed development is discussed in more detail in Section 4A.4.3. Development on federally managed lands within the National Petroleum Reserve-Alaska would occur under stipulations that require the lessee to allow access to subsistence-use areas and to consult with affected subsistence communities to address potential conflicts and identify measures that would prevent unreasonable conflicts with subsistence uses.

The proposed CPAI development does include development of a production pad, road, and pipeline within the buffer areas near Fish Creek, as well as some facilities within 500 feet of some other water bodies. These facilities and the road connecting separate oilfields within National Petroleum Reserve-Alaska will require exceptions from existing BLM stipulations. The proposed CPAI development would comply with all other BLM stipulations, alternative measures potentially required by the state, and the project specific procedures listed in Section 2, to reduce impacts to wildlife and subsistence. These stipulations and procedures are expected to minimize adverse effects to subsistence resources in this area and provide appropriate safeguards as called for in the subsistence standard.

Habitats (6 AAC 80.130)

The ACMP standard for habitats identifies eight habitat types and calls for management of these habitats to maintain or enhance their biological, physical, and chemical characteristics that contribute to their capacity to support living resources. In particular, the habitat standard calls for management of wetlands and tide flats to assure adequate water flow, nutrients, and oxygen levels, and to avoid adverse effects on natural drainage patterns, destruction of important habitat, and discharge of toxic substances. Rivers, streams, and lakes must be managed to protect natural vegetation, water quality, important fish and wildlife habitat, and natural water flow. Uses that do not meet these standards must meet a three-pronged test: (1) there must be a significant public need for the use or activity; (2) there must be no feasible prudent alternative to meet the need that would conform to the standards; and (3) all feasible and prudent steps to maximize conformance must be taken.

The applicant's proposed action, which calls for development of oil production and transportation facilities to bring Alaskan oil resources to the market, is expected to meet the three-pronged test. The project would provide a significant public benefit to the state in terms of economic benefits and to the nation in terms of increasing the domestic oil supply. Because of the extent of wetlands, lakes, rivers, and tidal areas throughout the Plan Area, there is no feasible way to develop the oil resources within the National Petroleum Reserve-Alaska and the Colville River Delta without affecting these habitats. Finally, development proposed under Alternative A has been designed to maximize conformance with the habitat standards for wetlands, tidal areas, creeks and lakes, to the extent feasible through compliance with all but three of the BLM stipulations in Appendix D.

Under this alternative, some development would occur within areas designated as resource buffers. As described above, this alternative requires exceptions from BLM's existing stipulations restricting permanent oil and gas facilities in the Fish Creek setback area, for facilities located within 500 feet of some other water bodies, and for the road connection between separate oilfields within National Petroleum Reserve-Alaska. All other BLM stipulations would be incorporated into the project as would the project specific procedures in Section 2. Roads, bridges, pipelines, and production pads are designed to minimize changes to natural drainage patterns and to migration of fish and wildlife as discussed in previous sections. The potential for releases of toxic substances would be reduced by using leak detection equipment and secondary containment for fuel storage facilities. Alternative A, with the BLM stipulations (with the exceptions noted), alternative measures potentially required by the state, and the project specific procedures described in Section 2, is expected to be in conformance with the habitat standard and the three-pronged test.

Air, Land and Water Quality (6 AAC 80.140)

The ACMP standards for air, land, and water quality incorporate reference to all the statutes, regulations, and procedures pertaining to those resources as enforced by the ADEC.

The ADEC regulates air and water quality as well as discharges of toxic substances to land and water. The ADEC regulates air emissions for industrial operations under the Clean Air Act. The proposed production pads would require review by the ADEC to address air emissions and to verify that emissions associated with the proposed development would not result in any violations of NAAQS or PSD increments. The existing processing facility at CD-1 operates under an Air Quality Construction Permit and a Title V operating permit, which would need revision to address any additional equipment and associated emissions. Water quality regulations include the ADEC stormwater pollution prevention plans for construction and operation, as well as the USEPA's NPDES permitting requirements. Wastes disposed of through the annulus of production wells are regulated by the USEPA's UIC program and the AOGCC. No Class I wells are anticipated to be required under CPAI's proposed plan. The ADEC also regulates hazardous substance releases to both land and water and requires approval of an ODPCP for new production pads so that best efforts are taken to minimize the potential for spills and that adequate spill response equipment and personnel are available to respond to spills in a timely manner. No new landfills are anticipated to be constructed under CPAI's proposed plan. Solid wastes generated at the proposed sites would be managed according to approved plans as described in Section 2.

Alternative A includes acquisition of all required state and federal permits. Compliance with relevant ADEC and USEPA regulations is expected to result in conformance with this coastal management standard for the proposed Alternative A – CPAI Development Plan.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

As stated in this ACMP statewide standard, "districts and appropriate state agencies shall identify areas of the coast which are important to the study, understanding, or illustration of national, state, or local history or pre-history (6 AAC 80.150)."

A review of the potential for cultural resources to be found within proposed development areas and the potential for adverse effects to cultural resources from facility development under Alternative A are discussed in Section 4A4.5. In addition to the regulations associated with Section 106 of the NHPA, stipulations on development within the National Petroleum Reserve-Alaska include requirements to identify the potential for adverse effects on cultural and traditional land use resources before development, avoidance or mitigation of these effects, and training for staff about cultural resource concerns during employee orientation. Archaeological surveys and other evaluations required prior to development would be completed and work would be required to stop in the event of discovery of previously unknown resources. Continued coordination with SHPO and development of appropriate cultural resource management plans, along with other project specific procedures identified in Section 2, BLM stipulations (with the exceptions noted), and alternative measures potentially required by the state, are expected to result in conformance of Alternative A with this coastal standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

For the NSB, the primary goal of the district's CMP Enforceable Policies is to balance economic development with protection of the Inuipiat culture, lifestyle and natural environment (NSB 1998). This includes ensuring that development activities do not substantially interfere with subsistence activities or jeopardize the continued availability of subsistence resources. Relevant NSB CMP policies include *Standards for Development*, *Required Features for Applicable Development*, *Best Effort Policies*, and *Minimization of Negative Impacts*. Many of these policies are consistent with the standards of the ACMP discussed above.

The current NSB *Standards for Development* (NSB CMP 2.4.3*)* require development to maintain subsistence resources at a level that meets local subsistence needs and to allow for continued access to those subsistence resources. The standards also call for protection of known and unrecorded cultural and historic sites through avoidance or consultation where resources cannot be avoided. Traditional activities at cultural and historic sites should not be adversely affected. Finally, the standards also call for compliance with all federal land, air, and water quality standards and regulations.

As discussed under the coastal management section above, subsistence resources and access to these resources are addressed through BLM stipulations requiring continued access to local subsistence users, alternative measures potentially required by the state, and design measures incorporated into the project to minimize potential impacts to fish and wildlife movements. Potential effects to cultural resources are addressed through compliance with Section 106, and avoidance or mitigation of these effects would occur in consultation with local and state officials. Proposed facilities and activities would be required to comply with all federal and state environmental regulations to protect public lands, air, and waters as required by the NSB policy.

The CMP *Required Features for Applicable Development* (NSB CMP 2.4.4) calls for restrictions on vehicle and aircraft activities in areas where wildlife species are sensitive to noise and movement during certain times. Required features also include compliance with state and federal regulations on water and air emissions, as well as solid waste facilities, and development of central sewage systems to process effluent to state and federal standards. Finally, fuel storage facilities with a capacity of more than 660 gallons must have an impermeable lining and be diked.

Development under Alternative A would incorporate construction and design measures that are intended to reduce impacts on fish and wildlife migration. As discussed above, the CPAI proposal incorporates compliance on BLM-managed lands with all but three of the stipulations listed in Appendix D. This alternative would require exceptions to the stipulations restricting permanent oil facilities within the Fish Creek setback area (stipulation 39), permanent oil facility infrastructure within 500 feet of some other water bodies (stipulation 41), and roads connecting separate oilfields within National Petroleum Reserve-Alaska (stipulation 48). Subsistence resources are further protected by the state of Alaska's Office of Habitat Management and Planning under Title 41 through its authority to require the proper protection of habitats important for the spawning, migration, and rearing of anadromous fish and its authority to require that durable and efficient fish passage is provided on all fish bearing water bodies. As discussed previously in this section, the proposed developments would be required to comply with all federal and state regulations on air, water, wastewater, and solid waste discharges, and fuel storage facilities are proposed to include secondary containment.

The current NSB *Best Effort Policies* (NSB CMP 2.4.5) reflect criteria similar to the three-pronged test under the ACMP. Development that cannot comply with all of the resource protection policies addressed previously could still be allowed if a significant public need exists for the development, if all feasible and prudent alternatives have been explored, and if all feasible and prudent steps have been taken to avoid the adverse effects that the resource protection policies were intended to prevent. This section of the CMP (NSB CMP 2.4.5.1) also requires minimization of impacts on subsistence resources and access, minimization of impacts to wildlife migration from transportation facilities (including pipelines), elimination of duplicative transportation corridors to proposed sites, and siting of structures to avoid flood and geologic hazard effects. Further requirements on applicable development (NSB CMP 2.4.5.2) include measures to reduce the environmental impacts of mining activities in coastal areas and floodplains; to locate, design, and maintain facilities to prevent significant adverse effects on fish and wildlife and their habitat, including drainage patterns; to locate all non-essential facilities at compact designated service bases and to share these facilities to the maximum extent possible; to consolidate transportation and utility facilities to the maximum extent possible; to minimize interference with use of traditional land use or subsistence areas; and to comply with the habitat standard of the ACMP.

These issues have been addressed above in the ACMP discussion. The proposed development meets an important public need, no feasible inland alternatives to development of the proposed facilities exist, and stipulations have been placed on the development to maximum conformance with the coastal management standards of both the ACMP and the CMP. Access to subsistence resources is protected through BLM stipulations and construction and design measures have been incorporated to reduce potential impacts to fish and wildlife resources. The processing and employee facilities at the existing Alpine Facility would be used to support the satellite developments. Roadways and pipelines have been co-located where possible and are designed to minimize effects to natural drainage patterns and wildlife movements. Therefore, development of the applicant’s proposed action under Alternative A is expected to comply with the NSB Best Effort Policies.

The NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). These standards include requirements for transportation facilities, including airstrips, to be sited, designed, constructed, and maintained to minimize adverse effects to wildlife and their migration, as well as minimizing effects on water courses and wetlands. Permafrost is to be maintained in developed areas and development must be sited, designed, and constructed to minimize the potential for loss of life or property from flooding, icing, erosion, and storms.

The proposed development under Alternative A includes design measures to protect permafrost and to address geophysical hazards as discussed above under the ACMP. Transportation facilities have been sited and designed to preserve existing drainage patterns and to minimize effects on fish and wildlife migration. The proposed development is expected to be consistent with the NSB CMP standards for minimizing impacts.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

Most of the land within the NSB is zoned as Conservation, with the exception of some village sites and the existing oilfields at Prudhoe Bay and Alpine. The NSB’s Resource Development zoning classification covers areas designated for oil development activities. Alternative A development east of the National Petroleum Reserve-Alaska in the Colville River Delta would require a re-zoning of the development areas to the Resource Development classification and permitting of activities through the approval of a master plan. Application of the

NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

ABANDONMENT AND REHABILITATION

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management may return to something similar to the current situation. For discussion of subsistence and recreation use after abandonment and rehabilitation, see sections 4A.4.3.1 and 4A.4.7.1, respectively.

4A.4.6.2 Alternative A – Full-Field Development Scenario Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

Development under Alternative A FFD would result in construction of proposed facilities on lands owned by the federal government, the state, and Kuukpik Corporation. Implementation of CPAI's proposed plan under Alternative A FFD would not change ownership status on lands within the ASDP Area, but would occur under negotiated leases.

Development of the FFD scenario would result in development occurring throughout the ASDP Area, with an additional 22 satellite production pads and associated roads and airstrips totaling an approximate impact area of 1,261 acres and 150 miles of pipelines. The FFD scenario would result in a substantial increase in the area developed and would provide additional access to areas farther west and north of the Plan Area. Access would remain limited to oil industry personnel and local subsistence users. Effects on subsistence resources and recreation for FFD are discussed in Sections 4A.4.3 and 4A.4.7.

In the areas of BLM-designated Special Areas, SMZs, and LUEAs within the National Petroleum Reserve-Alaska, Alternative A FFD would include development of a production pads, roads, and pipelines within LUEA buffer areas, SMZs, and Special Areas. In addition to the exceptions from the BLM stipulations discussed for the CPAI proposal above, the FFD would require an exception for development of a production pad and associated pipeline in the area near the Kogru River designated for no surface activities. Additional development within the Colville River Special Area, the Fish Creek buffer area, Sensitive Consultation areas around Fish Creek and the Colville River, and the special caribou stipulation area would be subject to additional consultation and review to minimize impacts to the greatest extent feasible.

The potential impacts to fish resources and subsistence activities from construction of oil and gas facilities adjacent to Fish Creek and in the other designated areas are discussed in detail in Sections 4A.3.2 and 4A.4.3, respectively.

COASTAL MANAGEMENT

Development proposed under Alternative A FFD includes construction and operation of 22 satellite production pads, two additional processing facilities, as well as roadways, pipelines, and an airstrip. As with Alternative A, most of these facilities are proposed on federal lands within the National Petroleum Reserve-Alaska; however, additional development would also be on state and Kuukpik lands within the coastal zone. Although federal lands are excluded from the coastal zone under the CZMA, development on federal lands is required to comply with state coastal programs to the extent possible; thus, this section evaluates proposed FFD against the state and local district coastal zone standards, regardless of whether or not the development occurs on federal lands. Standards of the ACMP include statewide standards found in regulations (6 AAC 80.040 – 6 AAC 80.150) and the enforceable policies of the affected coastal district, the NSB.

ALASKA COASTAL MANAGEMENT PROGRAM

As previously stated, the ACMP provides standards and guidance for development occurring within the coastal zone to balance development needs and the protection of valuable coastal resources. The state requirements in 6 AAC 80 address, but are not limited to, coastal development, recreation, development of energy facilities, transportation and utility routes, mining and mineral processing, habitats, preservation of historical resources, air and water quality, and solid-waste disposal. Effects of FFD under the listed state requirements are provided in the following section. The standard itself is stated under the effects of proposed Alternative A – CPAI Development Plan.

Coastal Development (6 AAC 80.040)

The FFD scenario proposes construction of additional oil production and transportation facilities throughout the ASDP Area, both within the National Petroleum Reserve-Alaska and outside the National Petroleum Reserve-Alaska in the Colville River Delta. Many of the proposed production sites under the FFD scenario are much closer to the coast, particularly at the northern coast of the Kalikpik-Kogru Rivers Facility Group of National Petroleum Reserve-Alaska and in the Colville River Delta. Development of access roads has been restricted in many of these areas, with airstrips included at the production sites for access. Again, development of potential oil reserves in these areas requires the development of production and transportation facilities near the oil reserves; therefore there are no feasible inland alternatives to the development. Development of the FFD facilities, in compliance with the BLM stipulations (with the exceptions noted) and alternative measures potentially required by the state to minimize potential effects to coastal resources, is expected to result in the compliance of this alternative with the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

Development of facilities under the FFD scenario would be required to meet the same design standards as proposed under the CPAI project to protect permafrost and to reduce the potential for damage to structures or personnel from floods geophysical hazards, and severe weather events. Incorporation of these design standards would be expected to adequately address this geophysical hazard standard.

Recreation (6 AAC 80.060)

The area affected by the FFD scenario has limited recreational use due to its remote location. Development of facilities under the FFD scenario would be required to comply with the same stipulations discussed for the CPAI development regarding continued access for subsistence and traditional land uses within the National Petroleum Reserve-Alaska. Development under Alternative A, given compliance with BLM stipulations addressing subsistence and traditional land uses access, as well as alternative measures potentially required by the state, is expected to comply with the recreation standard.

Energy Facilities (6 AAC 80.070)

Alternative A FFD would consolidate facilities to the extent possible; however, additional processing facilities beyond the existing Alpine Facility would be required. Roadways, pipelines, and other structures would be designed to minimize potential adverse effects on coastal resources to the greatest extent possible. Although more exceptions from existing BLM stipulations on locations of permanent oil and gas facilities would be required, compliance with the majority of the stipulations protecting scenic, recreational, and cultural resources and with alternative measures potentially required by the state, are expected to address the energy facility criteria and result in compliance with this standard.

Transportation and Utilities (6 AAC 80.080)

The FFD scenario calls for additional roads, bridges, and pipelines throughout the ASDP Area. Roads and pipelines serving each production site would be co-located, and regional processing facilities would be constructed in the vicinity of the production pads. The proposed coastal production pad near the Kogru River and the production sites proposed in the lower Colville River Delta would be accessed by air to avoid road construction in the areas closest to the coast. Exceptions to stipulations on construction of permanent facilities within some buffer areas and road access between separate oilfields would be required for this alternative. Based on the lack of alternatives that could avoid these sensitive areas, the BLM stipulations and alternative measures that will potentially be required by the state to reduce the adverse effects of construction of required roads, development under the FFD scenario is expected to conform with this standard.

Mining and Mineral Processing (6 AAC 80.110)

The Alternative A – Full-Field Development Scenario would likely require gravel resources beyond those currently identified. Any new gravel mining operation within the coastal zone would be required to receive a permit, which would maximize conformance with state coastal management standards and protection of coastal resources. In addition, the gravel mining permit process may impose additional mitigation measures. The lack of feasible alternatives, along with compliance with the majority of the BLM stipulations and alternative measures potentially required by the state, are expected to result in conformance with this standard.

Subsistence (6 AAC 80.120)

Development of FFD would result in more widespread development of roads, bridges, and pipelines through the ASDP Area. FFD would result in construction of facilities within the Fish Creek LUEA buffer area, within the buffer area on the upper Colville River, within a high-value caribou area within the Kalikpik-Kogru Rivers Facility Group, within an area restricted to surface development near the Kogru River, and throughout the lower Colville River Delta. Production pads in the lower Colville River Delta and other coastal areas would not be accessible by road and would require airstrips for access. Construction and operation of these facilities would be required to comply with the stipulations outlined in the Northeast National Petroleum Reserve-Alaska ROD (BLM and MMS 1998b) to minimize effects to subsistence to the greatest extent possible. Potential effects on subsistence from development under the FFD scenario are discussed further in Section 4A.4.3. Compliance with existing stipulations (with the exceptions noted) and alternative measures potentially required by the state is expected to result in conformance with the coastal standard for subsistence.

Habitats (6 AAC 80.130)

The Alternative A – Full-Field Development Scenario would result in additional impacts to the habitats identified above. Again, the development would be expected to meet the three-pronged test of serving an important public need, having no feasible inland alternative to development in these habitats, and being designed to maximize conformance to the standards through design and operations measures to minimize potential environmental impacts. As the FFD scenario does not specify exact locations of facilities, it is expected that the exact layout would be adjusted based on field studies and would be designed to maximize conformance with the coastal habitat standard. This alternative would require exceptions from some BLM stipulations regarding permanent oil facilities within resource setback areas and regarding road connections between separate oilfields. Other stipulations in Appendix D, as well as alternative measures potentially required by the state, would be incorporated into the project to reduce adverse effects on natural and cultural resources to the greatest extent feasible. Development of FFD would be expected to comply with the habitat standard through incorporation of the BLM stipulations with the exceptions noted and alternative measures potentially required by the state.

Air, Land, and Water Quality (6 AAC 80.140)

Oil production and transportation facilities proposed under the FFD scenario would likely require new Title V permits to address air emissions from the proposed new production and processing facilities. Stormwater pollution prevention plans and additional NPDES permits might be required to address potential water quality effects from the proposed facilities. Additional ODPCPs would be required to address prevention and spill response for the new facilities. The need for an additional landfill for solid wastes has not been determined at this point; however, any new landfill would be required to meet the ADEC solid waste permitting requirements. Compliance with ADEC and USEPA regulations are an essential requirement of FFD and would result in conformance with this coastal management standard.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

Under the FFD scenario, development would be spread over a much wider area and would be anticipated to encounter more cultural resources. As discussed above, adverse effects to any cultural resources identified through an inventory would require avoidance through siting refinements or mitigation through data recovery or other means. Potential effects on cultural resources from FFD are addressed further in Section 4A.4.5. Section 106 regulations, BLM stipulations (with the exceptions noted), and alternative measures potentially required by the state, are expected to protect cultural resources in accordance with the coastal management standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

As previously stated, for the NSB, the primary goal of the district's CMP Enforceable Policies is to ensure that development activities do not substantially interfere with subsistence activities or jeopardize the continued availability of subsistence resources, but are balanced with protection of the Inupiat culture and lifestyle (NSB 1998).

For the Alternative A – Full-Field Development Scenario, the current *NSB Standards for Development* (NSB CMP 2.4.3) requires that development maintain subsistence resources at a level to meet local needs, protect cultural resources, and comply with federal regulations on land, air, and water quality. Consultation would be conducted as required to address potential cultural resource effects. Development would require appropriate state and federal permits ensuring compliance with federal regulations. Compliance with project specific procedures in Section 2, the BLM stipulations (with the exceptions noted above), and alternative measures potentially required by the state, is expected to reduce impacts on fish and wildlife so that adverse effects to subsistence do not reduce subsistence resources below the level required for local needs.

Development under the Alternative A FFD scenario would incorporate construction and design measures that are intended to reduce impacts on fish and wildlife migration. Access to subsistence resources and to traditional land uses areas would be protected under the BLM stipulations and alternative measures potentially required by the state. The development would acquire all required USEPA and ADEC reviews and permits on air, water, and waste discharges as required under the CMP *Required Features for Applicable Development* (NSB CMP 2.4.4).

As addressed previously in the evaluation of Alternative A, the current NSB *Best Effort Policies* (NSB CMP 2.4.5) reflect criteria similar to the three-pronged test under the ACMP. As compared to the CPAI development proposal, the FFD scenario increases the extent of development throughout the ASDP Area. Major facilities, such as processing facilities, would be shared by multiple production sites to the extent feasible. Additional roadways and pipelines would be constructed and would require design measures to reduce potential effects on fish and wildlife habitat and movements. Many of the proposed sites, particularly in the Colville River Delta, would be limited to access by air. FFD would be expected to meet the current CMP best effort standards for public need, lack of alternatives, and minimization of adverse effects.

The NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). The proposed development under FFD for Alternative A includes design measures to protect permafrost and to address geophysical hazards as discussed previously under the ACMP. Transportation facilities have been sited and designed to preserve existing drainage patterns and to minimize effects on fish and wildlife migration. Although this alternative would require exceptions from some BLM stipulations as described above, compliance with the project specific procedures in Section 2, the other BLM stipulations in Appendix D, and alternative measures potentially required by the state, is expected to further reduce the development's impact on coastal resources. Thus, the proposed development is expected to be consistent with these CMP standards.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

Most of the land within the NSB is zoned as Conservation, with the exception of some village sites and the existing oilfields at Prudhoe Bay and Alpine Field. The NSB's Resource Development zoning classification covers areas designated for oil development activities. Development to the east of National Petroleum Reserve-Alaska in the Colville River Delta under FFD would require a re-zoning of the development areas to the Resource Development classification and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4A.4.6.3 Alternative A – Summary of Impacts (CPAI and FFD) on Land Uses and Coastal Management

Construction and operation of the Alternative A – CPAI Development Plan is not anticipated to result in adverse effects to existing land uses and ownership. A direct impact, however, would be the increase in the acres of developed land within the Plan Area. Implementation of the CPAI proposal under Alternative A would result in an increase of 2.4 times the total number of acres currently developed for oil production within the Plan Area. The Alternative A – CPAI Development Plan would require a BLM exception for construction and operation of permanent facilities within the designated Fish Creek setback area. CPAI would also have to obtain exceptions from BLM for development of some facilities within the 500 foot setback from other water bodies, and for the road connection between separate oilfields within the National Petroleum Reserve-Alaska. Development of facilities within the Colville River Special Area requires maximum protection of the area's surface resources, while allowing for development of the area's oil reserves. Incorporation of the BLM stipulations in Appendix D (with the exceptions noted), design and construction measures identified in Section 2, and alternative measures potentially required by the state, are expected to achieve maximum protection of the Colville River area's resources while allowing for oil facility development.

The proposed FFD of a production pad and associated pipeline in the area near the Kogru River, designated for no surface activities, would require another exception from BLM from the surface use restrictions for this area. Adoption of other elements of FFD also would require approval for additional development within the CRSA, the Fish Creek buffer area, Sensitive Consultation areas, and the special caribou stipulation area.

The proposed development, constructed and operated in compliance with the project specific procedures in Section 2, the BLM stipulations for the area (with the exceptions noted), and alternative measures potentially required by the state, is expected to be consistent with state and NSB coastal management policies. Implementation of Alternative A (CPAI and FFD) for areas east of the National Petroleum Reserve-Alaska would require NSB re-zoning from "Conservation" to "Resource Development" and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4A.4.6.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Land Uses and Coastal Management

No mitigation measures have been identified for Alternative A CPAI or FFD for land uses and coastal management.

4A.4.6.5 Alternative A – Effectiveness of Protective Measures for Land Uses and Coastal Management

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to coastal zone management, and since impacts are not expected from the CPAI proposal this EIS has not identified potential mitigation relative to coastal zone management.

4A.4.7 Recreation Resources

Potential effects on recreation from the applicant's proposed action were assessed by determining the various types of recreational uses occurring in the Plan Area. These uses were then evaluated to determine their sensitivity to the short-term and long-term effects of the projects. This assessment used both the results of discussions with outfitter guides operating in the Plan Area and previous knowledge of the Plan Area's natural resources.

4A.4.7.1 Alternative A – CPAI Development Plan Impacts on Recreation Resources

As noted in Section 3.4.7 the Plan Area is characterized by vast stretches of low wetland tundra with abundant wildlife resources and very low evidence human activity. Much of the recreational activity in the Plan Area is along the Colville River, with most organized recreation occurring or originating in the vicinity of Umiat to the south and Nuiqsut to the north. Most of the recreation in the project area occurs from May through September.

Most construction features associated with the proposed alternatives such as roads, pipeline construction, and gravel pad construction would occur during the winter months to minimize effects to the tundra environment. Very little organized recreation occurs during these harsh winter months, and only limited recreation occurs in the area during the summer months, as described in Section 3.4.7.

Potential effects on recreation from the Alternative A – CPAI Development Plan will likely include a loss of opportunities to experience wilderness-type values, such as naturalness and solitude, as well as a loss of area available for recreation because of development related activities (construction and operations). As explained in Section 3.4.7, the Plan Area provides opportunities for recreational visitors to experience naturalness and solitude associated with the SPM ROS class. Those engaging in non-subsistence hunting, hiking, and photography independent of outfitter guides would likely be subject to similar recreation-related impacts as outfitter guides, whose clients account for the majority of recreation users. The area also provides areas for wildlife viewing and limited fishing and hunting opportunities. Some opportunities for recreation would likely be reduced and some recreationists would be displaced (through loss of acreage available for recreational use) if the additional five satellites are developed. Under FFD, the effects are expected to be similar, but larger in scope.

Although the quality of the recreational experience in the Plan Area could also be indirectly affected through short- or long-term changes in ambient conditions, such as noise, interruption of views, or dust and odor, these issues are evaluated in detail in other sections of this document.

During construction, the estimated 100 to 150 summer recreation users, as well as the few winter recreation users (no specific numbers on winter recreationists are available) of the ASDP Area could be affected by noise, marred views, and disturbance to birds (affecting birdwatchers) and game and fish (affecting hunters and anglers). During the operations phase of the project, these effects would be lower in intensity, but they would be long-term in duration (over the life of the facility).

Long-term potential effects are expected to be greatest within 2 miles of the production pads, an area measuring approximately 8,000 acres per site. As a result, the applicant's proposed action to develop five pads could potentially affect the recreational experience, including values of solitude, quietude, naturalness, and wilderness, over approximately 40,000 acres. However, the recreational use of the Plan Area is very low, and most recreation occurs directly along the Colville River corridor where activities associated with Nuiqsut already have decreased the values of some of these recreational activities.

Therefore, actual effects to the recreational experience would be minor and would primarily be limited to activity associated with development across the Nigliq Channel, where there would be a decrease in opportunities associated with solitude, quietude, naturalness, and wilderness. Recreational opportunities in the Plan Area would remain consistent with the BLM's SPM classification.

ABANDONMENT AND REHABILITATION

While abandonment and rehabilitation activities are occurring, the small number of recreational users in the area of CPAI's development could have their experience diminished by noise, marred views, and disturbance to animals that they have come to observe (bird watchers) or harvest (fish and game). If upon completion of abandonment, roads are left in place and made available for the public, there would be greater access opportunities, especially if recreationists are able to utilize the airstrip at Alpine Field.

4A.4.7.2 Alternative A – Full-Field Development Scenario Impacts on Recreation Resources

Under FFD, the effects on hunting, fishing, and birding opportunities and the qualities of solitude, quietude, naturalness, and wilderness would be the same as those described for the Alternative A – CPAI Development Plan, as described previously. However, the potential for such effects would increase under this alternative as a result of the increased geographic scope of development. In addition to the potential effects on approximately 40,000 acres from the applicant's proposed action, the recreational opportunities on up to an additional 192,000 acres could be affected if as many as the 24 proposed processing or production pads are developed.

Actual effects to users would be greatest from the development of production pads, such as hypothetical pads HP-8 and HP-11, near the Colville River. Pads projected under FFD, particularly near the Colville River, and especially those near or above Nuiqsut, would increase the potential for indirect, short-term effects to recreation. These effects would mainly be from increased noise disturbance by aircraft traveling to and from the pad locations.

The noise associated with aircraft could alter wildlife movement, affecting hunting and bird-viewing opportunities in the Plan Area, specifically near HP-8 and HP-11. Because the species sought by big game hunters tend to roam over large areas within and near the Plan Area, and because the number of big game hunters visiting the Plan Area is small, no long-term effects on hunting under this alternative would be expected. However, there would likely be long-term effects to the solitude, quietude, naturalness, and wilderness (birding opportunities) values within approximately 2 miles of new facilities.

Overall, potential effects on recreation in the Plan Area would be localized (near new facilities), and no regional effects above current conditions would be expected.

4A.4.7.3 Alternative A – Summary of Impacts (CPAI and FFD) on Recreation Resources

Construction and operation of the facilities proposed under Alternative A (CPAI and FFD) in the Plan Area are not expected to result in more than local adverse effects to the lightly used recreational resources of the Plan Area.

4A.4.7.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Recreation Resources

No mitigation measures for recreation have been identified.

4A.4.7.5 Alternative A – Effectiveness of Protective Measures for Recreation Resources

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to recreation resources and this EIS does not identify potential mitigation measures for recreation.

4A.4.8 Visual Resources

4A.4.8.1 Visual Analysis Methodology

The visual analysis methodology includes three elements: (1) definition of management distance zones, which relates to how close or distant features are to likely viewers; (2) contrast ratings, or how much change results from new features in the visual landscape; and (3) photographic simulations of typical views with and without the proposed project facilities.

VISUAL RESOURCE MANAGEMENT DISTANCE ZONES

Distance from an object affects how well elements of a landscape are perceived, with visible details of a particular object decreasing with increasing distance. The VRM system recognizes three distance zones:

- **Foreground and Middle-Ground Zone**. This is the area that can be seen from a travel route for up to 5 miles. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.

- **Background Zone.** This is the remaining area that can be seen from a travel route to approximately 15 miles. It does not include areas in the background that are so far distant that the only thing discernible is the form or outline. To be included within this distance zone, vegetation should be visible at least as patterns of light and dark.

- **Seldom-Seen Zone**. These are areas that are not visible within the foreground, middle ground, and background zones, and areas beyond the background zones.

CONTRAST RATINGS

For the ASDP, a visual effect is considered adverse if a proposed project element (such as a drill rig) creates a strong contrast with the elements of the natural landscape. The BLM defines contrasts in the following manner.

- **None.** The element contrast is not visible or perceived.

- **Weak.** The element contrast can be seen but does not attract attention.

- **Moderate.** The element contrast begins to attract attention and begins to dominate the characteristic landscape.

- **Strong.** The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

For the following analysis, major infrastructure elements associated with the proposed developments were evaluated for the amount of contrast with the elements of the natural landscape. To aid in this assessment six visual simulations of different infrastructure elements were developed.

SIMULATIONS OF POTENTIAL CONTRASTS

KOPs are the most likely locations (communities, cabins, travel routes) where viewers would be able to observe the proposed project and would be visually affected by its presence. Initially, 24 KOPs located throughout the Plan Area were considered for preparation of visual simulations. From those 24, six were initially selected and ultimately three were chosen. It was decided that the tree that were eliminated (KOP 3, 14, and 18) were unrepresentative of potential visual impacts for analyses. Three were selected for impact analysis, KOP 12, 20, and 21. These KOPS were spread across much of the Plan Area and were selected to represent the 24 KOPs in the visual simulations. For each of these three KOPs, visual simulations were prepared and evaluated for the amount of visual contrast within the characteristic landscape. Simulations were conducted using BLM standards for visual simulations representing what would be seen through a 50mm camera lens. Table 4A.4.8-1 lists the six representative KOPs and their distance from each of the proposed five production pads and proposed structures associated with FFD. Most of the viewing distances are in the background or seldom-seen zone. However, KOPs #20 and #21 each have views within 5 miles or less of their locations, and views of KOP 12 are within 4 miles.

In accordance with BLM Visual Manual Section 8400, analyses of the visual effects of the applicant's proposed action were completed using visual simulations. Visual simulations used photographs of major oil- and gas-related structures, photographs of existing site conditions, and a digital terrain model with x, y, and z coordinates to generate photorealistic depictions of how proposed oil and gas satellites appear to observers. Major drilling equipment and facilities necessary for development of each oil and gas satellite were photographed during a site visit in July 2003. Photographs were taken with a 50 mm lens and represent what the unaided human eye would see. Engineering drawings and specifications for these equipment types and facilities were used to accurately model or "size" each structure before placing in it in the digital terrain model. Image editing software was used to blend the computer renderings of various structures with the photographs taken at KOPs.

TABLE 4A.4.8-1 VRM CLASSES FOR PROPOSED FACILITIES AND DISTANCES FOR REPRESENTATIVE KOPS

Proposed Facility	VRM Class	KOP #3	KOP #12	KOP#20	KOP #21	KOP #18	KOP #14
CD-1	II	15**	9	4*	5	6**	24
CD-2	II	15**	8	2*	4	3	22
CD-3	II	20	13	8**	5	9**	26
CD-4	II	11**	4*	2	7**	4*	22
CD-5	II	14**	8	3	5	1*	18
CD-6	III	16	13	12**	13**	10**	9**
CD-7	III	17	16	17	19	15	6**
HP-1	III	16	10**	8	9**	6**	13**
HP-2	III	19	18	19	21	17	5
HP-3	III	17	11**	6	5*	4*	17
HP-4	II	12	6	4	8**	6**	24
HP-5	II	17	11**	5*	1*	5*	22
HP-6	II	9**	3*	5*	10**	5	18
HP-7	II	18	11**	7	5	8**	26
HP-8	II	6**	2	7	13**	8**	23
HP-9	IV	4*	5*	11	16	11**	19
HP-10	III	20	21	24	27	22	11**
HP-11	II	10**	13**	16	21	16	15**
HP-12	II	20	15**	11	11**	13**	32
HP-13	II	24	18	14	12**	16	33
HP-14	II	24	20	16	15**	18	36
HP-15	IV	23	18	15	12**	13**	13**
HP-16	III	25	23	24	25	22	4

TABLE 4A.4.8-1 VRM CLASSES FOR PROPOSED FACILITIES AND DISTANCES FOR EPRESENTATIVE KOPS (CONT'D)

Proposed Facility	VRM Class	KOP #3	KOP #12	KOP#20	KOP #21	KOP #18	KOP #14
HP-17	III	29	29	30	31	28	10**
HP-18	III	28	25	23	23	21	5
HP-19	III	32	33	35	37	33	17
HP-20	III	35	33	32	32	30	12**
HP-21	IV	39	35	32	29	30	19
HP-22	IV	6**	31	27	22	25	21
HPF-1	III	37	34	32	30	30	14**
HPF-2	IV	21	19	19	20	17	2

Notes:
Distances are reported in miles.
* Distances represent the foreground-middle-ground zone.
** Distances represent the background zone.

VIEWS FROM VILLAGE OF NUIQSUT (KOP #12)

KOP #12 is on the north side of the village of Nuiqsut (N 70.23092°, W 151.01349° WGS84) (Figure 3.4.8.2-1). While viewer numbers are small (fewer than 200 per month), the importance of a natural landscape to the viewers is reflected in the VRM Class II designation. As displayed in Table 4A.4.8-1, KOP #12 is approximately 13 miles from CD-3, 4 miles from CD-4, 8 miles from CD-5, 13 miles from CD-6, and 16 miles from CD-7. CD-3, CD-4, and CD-5 could be within the same view, with the closest viewing distance being 4 miles (CD-4), while the farthest viewing distance would be 13 miles (CD-3). CD-4 and CD-5 would probably be discernable as structures at these distances. The viewing distance to CD-3 (13 miles) is far enough that it would probably be viewed as a blurry image from this location. These facilities would begin to attract attention on the landscape and result in a moderate contrast rating. For the Alternative A – CPAI Development Plan, the proposed facilities would be scattered in an almost 180-degree view.

Under the Alternative A – Full-Field Development Scenario, there would be an additional three production pads in the foreground-middle-ground zone. Drill rigs associated with the three pads and pipeline are 4 miles (foreground-middle-ground zone) from the KOP. The drill rigs would appear as distinct orange structures contrasting with the greens, browns, and grays of the stream corridor, and its vertical lines would contrast with the flat, horizontal landscape. The overall contrast of these FFD elements with the natural landscape would be noticeable, since the elements would begin to attract attention and would not be easily overlooked.

VIEW FROM NIGLIQ CHANNEL (KOP #20)

KOP #20 is near the Nigliq Channel (N 70.31232°, W 151.03888° WGS84) (Figure 3.4.8.3-5). This KOP represents views from water level and not from the uplands. (For a view from an upland area, see Figure 3.4.8.3-1, displaying CD-2 from approximately 5 miles.) While viewer numbers are small (fewer than 200 per month), the importance of a natural landscape to the viewers is reflected in the VRM Class II designation. As displayed in Table 4A.4.8-1, KOP #20 is approximately 8 miles from CD-3, 2 miles from CD-4, 3 miles from CD-5, 12 miles from CD-6, and 17 miles from CD-7. Under FFD, HP-4, HP-5, and HP-6 would be located in the foreground-middle-ground zone. Vertical contrast would be visible and would result in moderate contrast to the landscape characteristics. None of the proposed facilities would be within the same view, but the five proposed facilities would be scattered in an almost 360-degree view.

A drill rig and pipeline at CD-4 would be visible at a distance of approximately 2 miles**,** contrasting with the surroundings such as those simulated for KOP #12. The overall contrast of these facility elements with the natural landscape elements of form, color, line, and texture would be moderate.

VIEW OF NIGLIQ CHANNEL WITH VIEW OF CABINS (KOP #21)

KOP #21 is near the Nigliq Channel in view of cabins on the west side of the channel (N 70.39138°, W 151.08667° WGS84) (Figure 3.4.8.3-6). This KOP is situated along the uplands above river level. As displayed in Table 4A.4.8-1, KOP #21 is approximately 5 miles from CD-3, 7 miles from CD-4, 5 miles from CD-5, 13 miles from CD-6, and 19 miles from CD-7. Vertical contrast is visible and would create a moderate contrast in that the facilities begin to become noticeable on the landscape. CD-5, CD-6, and CD-7 could be within the same view, though the viewing distance to CD-7 (19 miles) is so great that it would probably not be visible from this location. The proposed structures of the Alternative A – CPAI Development Plan alternatives would be scattered in an almost 180-degree view. Under FFD, there would be an additional three production pads in the foreground-middle-ground zone.

The drill rig and pipeline at CD-3 would be slightly noticeable from KOP #21**,** contrasting with the surroundings in a manner similar to that described for KOP #12. The overall contrast of these facility elements with the natural landscape elements of form, color, line, and texture would be weak.

DETERMINATION OF IMPACTS

Impacts to visual resources were determined by evaluating whether VRM objectives were met. Table 4A.4.8-1 shows VRM class objectives for all proposed facilities**.** The majority of the facilities are in VRM Class II or VRM Class III areas. In VRM Class II areas, the level of change to the natural landscape should be weak, while for Class III areas the level of change should be moderate. A moderate contrast rating would not meet the intent of the objectives associated with VRM Class II, but would meet the objectives for Class III areas.

4A.4.8.2 Alternative A – CPAI Development Plan Impacts on Visual Resources

CONSTRUCTION PERIOD

Under the applicant’s proposed action, the presence of drill rigs (approximately 208 feet in height) would be the most noticeable effect of construction. Since drilling would be present and operational during the summer season at all but CD-3, the drill rigs would create a moderate contrast when viewed in the foreground zone, resulting in an adverse impact. The summer season represents the time of year when viewers would be traveling through the Plan Area and facilities are free of snow and there is adequate daylight for viewing. Drill rigs would introduce vertical lines and dominate the landscape. Activities such as pad construction and road construction would have a negligible impact because the construction activities would occur in the winter when snow and darkness make viewing activities difficult.

OPERATION PERIOD

Facilities associated with operation of the production pads would introduce a strong contrast with the natural landscape. Most of the buildings associated with the proposed action are less than three stories high (less than 60 feet), while communications towers could be up to 200 feet high. These vertical structures would then be 200 feet higher than the surrounding landform and would contrast with the predominant horizontal line of the surrounding landform. Power poles (limited to the area between CD-6 and CD-7) would be spaced 250 feet apart and would add vertical contrast to the natural landscape, though they would not be as noticeable as communication towers. Bridges across water bodies, especially the Nigliq Channel, would repeat the horizontal line of the landform but would contrast with the colors of the surrounding landscape. Emergency spill response containers located along channels also would contrast with the colors of the surrounding landscape. Pipelines would be elevated 5 feet above the ground surface and would follow the horizontal landform of the landscape.

Buildings, drill rigs, and communication towers also would contrast in color with the dominant vegetation. Roads would contrast with much of the surrounding vegetation colors, but would not dominate views with distances of more than one mile, since they would only be 5 to 10 feet higher than the tundra. When viewed from more than 1 mile away, roads and airstrips would appear as elevated horizontal lines. Vehicle traffic on roads, and aircraft take-offs and landings, would be noticeable for short durations primarily from the creation of fugitive dust. Because of the nature of gravel mining, only stockpiled material would be visible. Lighting of facilities for night operations would produce sky glow in an otherwise dark landscape.

ABANDONMENT AND REHABILITATION

During abandonment and rehabilitation, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of fugitive dust. Once these activities are completed, contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, will be eliminated.

4A.4.8.3 Alternative A – Full-Field Development Scenario Impacts on Visual Resources

Both construction and operation of multiple production pads would introduce numerous moderate contrasts with the natural landscape. Under FFD, viewers would more likely be able to see evidence of construction or operation of production pads. The addition of two more central processing facilities would introduce a moderate visual contrast with the natural landscape, resulting in an adverse impact.

4A.4.8.4 Alternative A – Summary of Impacts (CPAI and FFD) on Visual Resources

Under Alternative A (CPAI and FFD), construction and operation would result in adverse effects to visual resources. Activities such as pad construction and road construction would have a negligible impact because the construction activities would occur in the winter when snow and darkness make viewing activities difficult. The summer season represents the time of year when viewers would be traveling through the Plan Area and facilities are free of snow and there is adequate daylight for viewing. The facilities and structures associated with operation would introduce contrast with the natural landscape. When viewed from the foreground-middle-ground zone, these structures would produce a moderate contrast with the natural landscape.

4A.4.8.5 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Visual Resources

Potential mitigation measures for visual resource impacts would include:

1. All structures would be painted to blend with the natural environment. All colors would be pre-approved by the AO. This includes emergency spill containers located along watercourses. BLM will use computer generated colors to determine the color for structures that blend in best with the background colors of the natural landscape and may do a color test onsite. Self-weathering steel, or best management practice, will be used on all metal structures not otherwise painted, including but not limited to pipelines, communications towers and drill rigs, thus providing a more natural color of brown.

2. Except for safety lighting, illumination of all structures, including drilling structures, production facilities, or buildings shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.

4A.4.8.6 Alternative A – Effectiveness of Protective Measures for Visual Resources

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to visual resources. However, this EIS recommends mitigation that would blend structures and permanent facilities with their surroundings and reduce impacts from the lighting of the facilities.

4A.4.9 Transportation

Potential effects to transportation resources include changes to traffic volume and circulation on existing and proposed roads, airports, marine, and rail facilities. Increased traffic volumes are assessed to determine whether they would exceed transportation facility capacities, or adversely affect traffic flow and safety. Potential secondary effects associated with provision of new transportation resources and increased access to formerly remote areas include adverse effects on wildlife, recreation, and subsistence from increased activity levels in areas that are currently difficult to access. These impacts are discussed in their respective sections.

Because proposed development would occur in an area with no public transportation infrastructure and no public information on traffic volumes by type of transportation, the applicant's proposed action does not lend itself to quantification of traffic impacts. Professional transportation planning judgment was applied to reach reasonable conclusions about the potential effects on transportation resources.

4A.4.9.1 Alternative A – CPAI Development Plan Impacts on Transportation

ROADWAYS

The Alternative A – CPAI Development Plan would result in the construction of one new airstrip at CD-3, 26.0 miles of new gravel roads, and 35.6 miles of pipelines within the Plan Area. Use of the roadways and airstrip would be restricted to agency staff, oil industry personnel and contractors, and residents of the village of Nuiqsut.

CONSTRUCTION PERIOD

Construction activities proposed under the Alternative A – CPAI Development Plan would occur in phases during the next several years. The construction workforce would range from 50 to 625 personnel during various construction seasons. Non-local construction personnel would likely travel to the North Slope by jet and then travel to their assigned housing locations by smaller air transport or by road. Personnel transport to specific construction sites would primarily occur by road, or by air at CD-3. Personnel transport associated with construction activities would occur primarily within the Plan Area. No adverse effects on any industry or public roadways are anticipated.

Construction material would likely be transported by road, sea, and air, depending on the season and the stage of construction. Most freight and materials delivered to the North Slope are delivered by truck along the Dalton Highway. Traffic on the Dalton Highway is well below the roadway capacity, averaging fewer than 300 vehicle trips per day in 2002. Truck traffic on the highway would increase during construction, raising the %age of trucks beyond its current 40 %. The increased truck traffic on the road would be similar to construction traffic peaks that have occurred during previous oilfield construction periods on the North Slope and are not expected to adversely affect traffic flows on the Dalton Highway.

Transport of materials from the oil industry roadway system at the North Slope to construction sites within the Plan Area would primarily occur over ice roads during winter construction periods until the proposed gravel roads and bridges have been constructed. These ice roads and gravel roads would be designed specifically to provide construction and operations access to production sites and are expected to provide the required capacity for transport of construction materials throughout the construction period.

Construction traffic would vary by season, with up to 18,600 round trips per month possible during the initial winter construction season during 2004 and 2005. Because most of this construction traffic would occur on industry-constructed roadways with no public access, no adverse effects on public roadway systems are anticipated.

OPERATION PERIOD

Operation of the facilities proposed under the Alternative A – CPAI Development Plan for the applicant's proposed action would result in a much lower level of traffic than is anticipated during construction. Road traffic within the Plan Area would be limited to transport of employees and operating supplies from APF-1 to the other production pads on the gravel roads connecting most of the sites to the existing facilities. Much of the supply transport from outside the Plan Area would occur by truck on the Dalton Highway to the North Slope. During winter, supplies would be transported into and within the Plan Area by using low ground pressure vehicles or truck transport on ice roads. High-value, low-weight supplies or other essential supplies that cannot wait to be sent until winter could be shipped in by air to the existing facility and transported to the production pads by air (particularly for CD-3) or by ground. As described above, the oil industry roads on the North Slope have limited access. The increased truck traffic on the Dalton Highway resulting from operation of the five proposed pads is expected to be well within the capacity of the road. Likewise, increased traffic on oil industry roads during operations would be far less than during construction and should not result in any adverse effects on ongoing traffic operations of the North Slope oilfields.

Construction of the roads and bridges linking the existing Alpine Facility to production pads west of Nigliq Channel would result in the first year-round road access to areas west of the channel. These proposed roadways would provide additional access for Nuiqsut residents to areas within the Fish-Judy Creeks Facility Group that are currently difficult to access during the summer months. This additional access would result in more human activity in these areas related to operation of the production pads during summer months. Although the proposed roads would provide new access to these areas, the potential effects would be lessened somewhat because the proposed roads would not provide direct access to Nuiqsut, the oil industry roads east of the Plan Area, or the Dalton Highway. Potential effects to subsistence resources from this increased access are addressed in Section 4A.4.3 and Section 4A.3.

RAILROAD TRANSPORTATION

CONSTRUCTION PERIOD

Under the Alternative A – CPAI Development Plan, some construction materials from outside Alaska would likely be transported from Alaska ports of entry to Fairbanks by railroad and then transferred by truck to the North Slope. The Alaska Railroad Corporation has provided these services as required during previous oil industry construction activities on the North Slope. The railroad is expected to have sufficient capacity to accommodate construction transport needs for the applicant's proposed action.

OPERATIONS PERIOD

Although rail transport plays a minor role in transportation of materials during operations, it is the most economic means for shipping some large, heavy goods. The railroad is expected to have sufficient capacity to accommodate additional transport needs associated with operations of the new pads.

MARINE FACILITIES

CONSTRUCTION PERIOD

Marine transportation of heavy construction equipment or other materials with a low value-to-weight ratio could occur by barge proposed under the Alternative A – CPAI Development Plan. Marine transportation would likely play a role in movement of construction material from the Lower 48 states to Alaska and from Anchorage to the North Slope. Alaska ports and marine transport firms have historically provided sufficient capacity during previous construction activities on the North Slope and are expected to have sufficient capacity to meet any demands for marine transport associated with construction activities during the next 10 years.

OPERATIONS PERIOD

Transport of supplies during normal operations does not typically involve marine transport. Therefore, operation of the facilities proposed under Alternative A would not affect any other marine transport facilities.

RIVER TRANSPORTATION

CONSTRUCTION PERIOD

Most construction in the vicinity of rivers would occur during winter until gravel roads and bridges have been installed. Construction activities may interfere with some winter travel on frozen channels, but the interference is expected to be limited and it is expected that local residents' travel needs will be accommodated through construction areas.

OPERATIONS PERIOD

The Alternative A – CPAI Development Plan proposes construction of bridges over the Nigliq Channel, the Ublutuoch River, and five smaller water bodies. Pipelines between CD-1 and CD-3 would also cross the Sakoonang, Tamayagiaq, and Ulamnigiaq channels. Road and pipeline bridges across channels and rivers commonly navigated by industry and local residents will provide at least 20-foot clearance. Under this alternative, the bridges over the Nigliq Channel would be approximately 1,200-foot long and the Ublutuoch River Bridge would be approximately 140-foot long. Bridge designs would address water surface elevations and velocities, scour protection, ice impacts and jams, storm surges, and waterway opening requirements. The 20-foot clearance for the bridge over the Nigliq Channel would accommodate the boats typically used for spill response. Only one spill response boat, the Agviq, would require modifications to be used in the area of this bridge. Most village boat heights are about 10 feet above water level with aerials that reach to 20 feet. These aerials are easily retractable and would not inhibit travel under the 20-foot bridges.

Two docks would be constructed to provide river access for spill response. One dock would be deployed seasonally at CD-3 to provide access to the East Ulamnigiaq Channel. The second dock would be a permanent installation at either CD-2 or CD-4 to provide access to the Nigliq Channel. The limited use of these facilities for spill response and spill response training is not expected to adversely affect local use of the river. Therefore, operation of the facilities proposed under this alternative are not expected to adversely affect river transportation.

AVIATION FACILITIES

CONSTRUCTION PERIOD

Shared Services Aviation currently transports approximately 20,000 passengers to and from the North Slope per month. The maximum construction workforce for any one season is 625 workers. If this entire workforce required transportation to the North Slope in one month it would increase existing passenger loads by less than 5 %.

Shared Services Aviation transports personnel within the North Slope area with the use of Twin Otters and CASAs. These aircraft currently provide as many as nine daily flights into the Alpine Facility. During a 1-year construction and drilling period, it is estimated that this alternative would require approximately 700 landings by small aircraft (CASA or Twin Otter) for personnel, 250 landings for cargo aircraft (DC-6), and 20 landings by C-130 Hercules Aircraft (CPAI 2003b). The CASA and Twin Otter currently fly more than 100 flights per week on the North Slope, and this construction activity is expected to increase flights by less than 13 % from current activity levels. Increased demand for cargo and helicopter flights are also expected to be easily accommodated with existing commercial and charter aviation services. This level of increased demand for flight support would not be expected to have an adverse effect on aviation facilities or services to and within the North Slope.

OPERATIONS PERIOD

Transport of personnel and materials during operations is expected to require up to 40 roundtrip flights per month, including trips into and out of CD-1 and trip to CD-3, three times per week. This would not be expected to result in any adverse effect on aviation facilities or services to and within the North Slope.

This alternative proposes locating electric lines on 60-foot poles between CD-6 and CD-7. Local general aviation pilots have expressed concerns regarding the potential for these lines to create a safety hazard for aircraft flying at low elevations during marginal weather conditions. Although poles of this height are generally not regulated by the FAA due to the limited aviation operations that occur at that elevation, if aircraft do operate in this area at that elevation in poor visibility conditions, the poles could create a safety hazard.

PIPELINES

CONSTRUCTION PERIOD

There would be no effects on existing pipeline facilities during the construction phase.

OPERATIONS PERIOD

The existing 14-inch pipeline from the Alpine Central Processing Facility to Kuparuk currently carries approximately 100,000 bbl of oil per day to Kuparuk and then on to TAPS Pump Station 1 for transport to Valdez. Production from the applicant's proposed action would be phased in over time as production decreases at the existing Alpine well sites. Production flows under this alternative would be managed to remain within the capacity of the existing sales oil pipeline from the Alpine Facility to Kuparuk.

TAPS was designed to accommodate a maximum throughput of 2.2 million MMbbl per day. Currently the year-to-date average oil throughput of TAPS is 995,000 MMbbl per day, or less than 50 % of capacity. The increase in oil throughput associated with the facilities for the applicant's proposed action during the production period is expected to be offset by decreasing output from older, established North Slope facilities; therefore, the projected increase in throughput to TAPS is expected to remain well within the capacity of the pipeline.

ABANDONMENT AND REHABILITATION

During the dismantelment and removal phase there would be increased traffic demands on the current public transportation system, including the industry spine road, the Dalton Highway and, to a lesser extent, the Alaska Railroad and marine facilities, and to the road system built by CPAI for the satellites. These transportation systems would be adequate to handle the traffic and no adverse impacts are anticipated on public transportation systems. If the roads CPAI proposes to build are left in place and maintained, additional transportation infrastructure would be available in the area, though not connected to other roads.

4A.4.9.2 Alternative A – Full-Field Development Scenario Impacts on Transportation

ROADWAYS

Construction impacts to roadways under the Alternative A – Full-Field Development Scenario would be similar to those identified for the Alternative A – CPAI Development Plan. The Dalton Highway would be expected to see increased truck traffic associated with transport of construction materials and supplies. Although no construction schedule has been identified for FFD, it is likely that construction of these facilities would occur incrementally over a long time. Because of the low traffic volumes on the Dalton Highway, it is likely that the highway could accommodate the increase in truck traffic for FFD with little adverse effect on highway traffic.

Operations traffic associated with FFD would be substantially higher than that associated with the CPAI Development Plan. The affected roads would be industry roads specifically designed to accommodate construction equipment and commercial truck traffic. No public access would be allowed on the proposed roads, other than for residents of Nuiqsut.

RAILROAD TRANSPORTATION

Development of the production and processing facilities proposed for the FFD Plan would be expected to occur in a phased manner over a long time. Alaska Railroad Corporation would be expected to play a role in transporting project construction materials and operating supplies. The demands on the railroad for construction and operation of FFD have not been estimated; however, it is likely that Alaska Railroad Corporation could meet the construction and operation needs without adversely affecting ongoing railroad operations.

MARINE FACILITIES

Phased construction of the FFD Plan would likely occur over many years. Although the demand for marine transport has not been quantified, it is assumed that existing marine support services could accommodate the construction and operations demand associated with the FFD Plan.

RIVER TRANSPORTATION

Construction activities near navigable channels are most likely to occur during the winter. These activities could impact use of frozen waterways and would require consultation with residents of Nuiqsut to determine appropriate detours or other means to allow access through construction areas. In addition, use of ice bridges across navigable waterways could delay access to these waterways in the summer. The additional road and pipeline crossings of navigable channels are expected to be designed in a manner that minimizes impacts to navigability. However, there could be adverse impacts to some river transport, particularly larger vessels such as the Agviq.

AVIATION FACILITIES

The FFD Plan would require additional air support during construction and operations, especially for construction of the production pads in the lower Colville River Delta, where no roads are proposed for construction. Although transport of personnel from Anchorage or Fairbanks to Deadhorse, Kuparuk, or both is not expected to result in a substantial change in jet flights to the North Slope, the demand for flights from Kuparuk to the facilities proposed to be located throughout the Plan Area could change substantially, increasing an estimated 40 %.

The only electric line proposed to be placed on 60-foot poles would be the line between CD-6 and CD-7 as described under the CPAI development plan above. This line could create a safety hazard for aircraft flying at extremely low elevations in poor visibility conditions.

PIPELINES

Under the FFD Plan, development and production would be phased so that the supply of sales oil would not exceed the capacity of the existing sales oil pipeline. Because oil production from existing North Slope fields continues to decline, the capacity of TAPS is expected to be adequate to transport oil from the FFD Plan.

4A.4.9.3 Alternative A – Summary of Impacts (CPAI and FFD) On Transportation

Construction and operation of the facilities proposed under Alternative A (CPAI and FFD) in the Plan Area are not expected to result in adverse effects to transportation resources. Existing and proposed roads, airstrips, and pipelines are expected to adequately transport personnel, materials, and product throughout the Plan Area and into statewide transportation systems. Both local and statewide transportation systems are considered to have adequate capacity to accommodate the level of activity anticipated during construction and operation of the facilities. The electric lines placed on poles between CD-6 and CD-7 would have some potential to increase safety hazards for aircraft operations during poor weather conditions.

4A.4.9.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Transportation

To address the potential safety hazard associated with electric lines on 60-foot poles, these poles could be marked according to normal FAA requirements for structures above 200 feet. This could consist of red lights on the poles and high-visibility markers on lines where appropriate.

Most bridge construction activities will be conducted when the impacted waterways are frozen. If not, the applicant should work with local village and other vessel operators in order to facilitate marine navigation during construction. If bridge construction activities requires limiting vessel traffic, the applicant should issue sufficient notification of such closures to reduce conflict with marine navigation activities. A condition of the applicant's Coast Guard Bridge permit will require that construction of falsework, cofferdams or other obstructions, if required, shall be in accordance with plans submitted to approved by the Commandant prior to construction of the bridges. All work shall be so conducted that the free navigation of the waterway is not unreasonably interfered with and the present navigational depths are not impaired. Timely notice of any and all events that may affect navigation shall be given to the District Commander (Seventeenth District) during construction of the bridges.

4A.4.9.5 Alternative A – Effectiveness of Protective Measures for Transportation

There are no Northeast National Petroleum Reserve-Alaska AP/EIS stipulations that apply to transportation resources and there were no mitigation measures developed in this EIS.

TABLE OF CONTENTS

PAGE

SECTION 4B DIRECT AND INDIRECT IMPACTS – ALTERNATIVE B 675

LIST OF TABLES

PAGE

SECTION 4B
DIRECT AND INDIRECT IMPACTS – ALTERNATIVE B

4B.1 INTRODUCTION

This section provides an analysis of the environmental consequences that would result from implementation of Alternative B – CPAI Development Plan and Alternative B – FFD.

Except for those aspects specifically discussed below, the components of Alternative B are the same as those for Alternative A. Differences between the two alternatives provide for conformance to Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations, and include:

- Moving proposed permanent oil infrastructure to a distance at least 3 miles from Fish Creek (Stipulation 39[d]). This requires that CD-6 and associated roads and pipelines be moved from within the setback.

- Moving proposed permanent oil infrastructure to a distance of at least 500 feet from water bodies, excepting essential pipeline and road crossings (Stipulation 41). Roads and pipelines would be moved to conform to this provision to the maximum extent possible

- Eliminating roads to a road network outside BLM-managed lands within the Plan Area (Stipulation 48). Road connection between CD-6 and CD-7, on the one hand, and other facilities, on the other hand, are eliminated

In addition, access to roads would be restricted to industry personnel only.

Alternative B – FFD also would conform to Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations. The Teshekpuk Lake Special Area would preclude development in the northwestern part of the Plan Area near the Kogru River. This would eliminate HP-22. Several other facilities would have to be relocated outside the Fish Creek buffer.

4B.2 PHYSICAL CHARACTERISTICS

4B.2.1 Terrestrial Environment

4B.2.1.1 Physiography

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON PHYSIOGRAPHY

CONSTRUCTION PERIOD

Effects on physiography would result from changes to landforms by construction of roads, production pads, airstrips, and gravel mines. The impacts are therefore similar to those discussed in Section 4A.2.1.1 for Alternative A.

Areas where gravel mining operations would directly affect the physiography include 37 acres (Section 4B.2.1.4) of gravel mine. Placement of gravel on the tundra would directly affect physiography on 204 acres (Table 2.5-1).

OPERATION PERIOD

Effects during the operation period would be similar to those under Alternative A.

ABANDONMENT AND REHABILITATION

Impacts of abandonment under Alternative B would be similar in nature to those under Alternative A, but Alternative B would potentially leave fewer changes than Alternative A, because there would be 16 fewer miles of roads constructed.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PHYSIOGRAPHY

Areas that would experience direct physiographic effects from gravel mining operations under Alternative B – FFD encompass approximately 287 acres. Areas that would experience direct physiographic impacts from placement of gravel on tundra encompass 1,049 acres.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON PHYSIOGRAPHY

Impacts to physiography would occur primarily during the construction phase and result from changes to landforms by construction of roads, production pads, airstrips, and mine sites. If not properly designed and constructed, these landforms can adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PHYSIOGRAPHY

No measures have been identified to mitigate impacts to physiography under Alternative B or Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PHYSIOGRAPHY

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.1.2 Geology

Plan Area geology is comprised of marine limestones and marine and deltaic sands and shales of Mississippian to mid-Cretaceous age (Gyrc 1985), mantled largely by Quaternary-aged fluvial and glaciofluvial sediments (Rawlinson 1993). Oil production efforts in the Plan Area target a Jurassic sandstone reservoir located in the Beaufortian Sequence (BLM 2003b).

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON GEOLOGY

CONSTRUCTION PERIOD

Direct Effects

Drilling oil production wells at the five pad locations (CD-3 through CD-7) would directly impact the physical integrity of reservoir and overlying bedrock by pulverization and fracture. The only surface bedrock identified in the Plan Area outcrops at the bend in the lower Colville River, upstream of Ocean Point (Mayfield et al. 1988). Alternative B does not propose excavation activities in this area and would therefore not directly impact surface bedrock. The volume of rock impacted by drilling is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during construction would produce no measurable effect and are considered negligible under this alternative.

Indirect Effects

No indirect effects are recognized for the construction period.

OPERATION PERIOD

Direct Effects

Annular disposal or injection of Class I and II wastes would directly impact the receiving bedrock via possible propagation of existing fractures, increase of pore space pressure, and alteration of pore space composition within an approximately 0.25-mile radius of the well (40 CFR 146.69 (b)). The volume of rock impacted by waste disposal is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during operation would produce no measurable effect and are considered negligible under this alternative.

Production of petroleum hydrocarbons from subsurface reservoirs constitutes an irreversible and irretrievable commitment of resources. Direct impacts to petroleum hydrocarbon resources in the Plan Area would be major under this alternative.

Indirect Effects

No indirect effects are recognized for the operation period.

ABANDONMENT AND REHABILITATION

Geology will not be impacted by abandonment activities under Alternative B – CPAI Development Plan.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON GEOLOGY

Direct and indirect impacts incurred during construction and operation of Alternative B – FFD would be similar to those presented in Section 4B.2.1.2.1, but would be experienced over greater spatial and temporal extents. Direct impacts to Plan Area bedrock would remain negligible under the Alternative B – FFD. Direct impacts to Plan Area petroleum hydrocarbon reserves would be major under this alternative.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON GEOLOGY

Under either alternative, the irreversible and irretrievable commitment of petroleum hydrocarbon resources constitutes a major impact, however petroleum hydrocarbon production is the purpose of the applicant's proposed action. Impacts to bedrock under either alternative would be negligible.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR GEOLOGY

Mitigation of impacts to petroleum hydrocarbons would be in conflict with the purpose of the applicant's proposed action. Therefore no measures have been identified to mitigate the effect on geologic resources under Alternative B nor Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR GEOLOGY

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.1.3 Soils and Permafrost

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON SOILS AND PERMAFROST

Construction and operation of Alternative B would involve impacts similar in type but different in magnitude to those presented under Alternative A (Section 4A.2.1.3). Compared to Alternative A, Alternative B involves less road construction (due to elimination of a road network outside of BLM-managed lands) and proposes power cable burial (as opposed to construction of an overhead powerline or inclusion of a power cable tray on pipeline VSMs). Except where noted, assumptions involved in the following calculations of soil and permafrost impacts do not differ from those presented in Section 4A.2.1.3. Impacts of abandonment under Alternative B would be similar in nature to those under Alternative A. However, if the rehabilitation preference is for removal of gravel pads, there would be less impact to the thermal regime between CD-2 and CD-6, because there would not be a road bridge over the Nigliq Channel, nor a road between CD-2 and CD-6 to be removed.

CONSTRUCTION PERIOD

Relative to Alternative A, Alternative B would eliminate the road connection between CD-2 and CD-6, thereby reducing the total road length from 26 to 10 miles. Reduction in road miles translates to a lesser need for fill, a minimization of impacts associated with excavation of fill, fewer culverts and bridges, and reduced length of ice roads. Under Alternative B, 1.6 million cy of fill would overlie approximately 204 acres of tundra. This footprint would be 37 acres less than that proposed under Alternative A. Extraction of the gravel required for construction of Alternative B would impact a total of 37 acres of tundra and would require a total of 38 acres of ice pad for stockpiling overburden at the ASRC Mine Site and at Clover. Temporary ice roads and adjacent ice pads would cover approximately 1,384 acres of tundra over six winter seasons—this area is 155 acres less than that estimated for Alternative A. Elimination of the road connection between CD-2 and CD-6 reduces the number of bridges required under Alternative B to two, and the area of ice pads associated with bridge construction to 59 acres. Installation of 110 culverts and 3,504 VSMs under Alternative B would disturb approximately 2,300 and 12,500 cy of soil, respectively. Impacts associated with water discharges to the tundra and tundra travel during the construction period are assumed to be of the same magnitude as those under Alternative A.

Under Alternative B, power cable would not be run over head or in a tray on pipeline VSMs. Alternative B proposes to bury power cable in roads, or in tundra between pads not connected by roads. Due to the thick depth of fill, power cable burial in gravel roads would not disturb the underlying soils and permafrost. However, power cable burial in the tundra would directly impact soils. Power cable burial involves cutting a trench through an ice road, placing the cable, and pushing the cuttings back into the trench. Relative to summer insertion, winter insertion of cables typically leaves a wider swath of barren soil on the tundra (Truett and Johnson 2000). Alternative B would require 20 miles of trenching in tundra between CD-3 and CD-1 and between CD-2 and CD-6. Assuming a trench depth of 5 feet and width of 1-foot, this alternative would disturb 19,519 cy of active layer soils. Power cable burial in tundra represents a significantly greater impact than the installation of VSMs or power poles. Power cable burial would disturb 978 cy of soil per mile, whereas VSM and power pole installation would disturb 343 and 38 cy of soil per mile, respectively.

OPERATION PERIOD

Reduction in road miles would minimize the indirect impacts associated with road travel and maintenance occurring during the operation period. Reduction of dust fallout and accumulations of plowed snow and sprayed gravel would minimize the thermal impacts to active layer soils and permafrost. The area of thermal impact calculated for Alternative B is 635 acres; 517 acres less than that under Alternative A. Quantification of thermal impact for Alternative B does not account for permafrost impacts due to trenching; an additional 2.4 acres would be disturbed by trenching. Trenching in tundra soils would alter soil properties and destroy the overlying vegetative mat. Truett and Johnson (2000) reported that thermokarst creates a persistent linear feature where power cable burial disturbs ice-rich sediments. Although power cable burial in tundra is likely to degrade permafrost, this activity represents a short-term and spatially constricted impact, whereas disturbance to roadside permafrost would be sustained for the duration of the operation period and could extend up to 164 feet from the road (Hettinger 1992, BLM and MMS 1998a and 2003b). Therefore, recovery from trenching would likely be faster than the rate of recovery experienced by roadside soil and permafrost. Operation period impacts associated with tundra travel, transmission of warm reservoir fluids, sub-permafrost injection of waste, and accidental oil spills are assumed to be of the same magnitude as those under Alternative A.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SOILS AND PERMAFROST

Construction and operation of Alternative B – FFD would involve impacts similar in type but different in magnitude to those presented for Alternative A – FFD (Section 4A.2.1.3). Compared to Alternative A – FFD, Alternative B – FFD eliminates construction of roads and production pads in areas not permitted for permanent oil and gas facilities, or not available for oil and gas leasing, respectively (BLM 1998). It also proposed power cable burial, as opposed to construction of an overhead powerline or a power cable tray supported by pipeline VSMs.

CONSTRUCTION PERIOD

Relative to Alternative A – FFD, Alternative B – FFD would eliminate HP-22 and its road connections to HP-11 and HP-15, and road connections between HP-18 and HP-26 and between HP-18 and HPF-1. This would reduce the total number of HPs to 21 and road length from 122 to 94miles. Such a reduction translates to a lesser need for fill, minimization of impacts associated with excavation of fill, and fewer culverts and bridges. Under Alternative B – FFD, 7.6 million of fill would overlie approximately 1,049 acres of tundra. This footprint would be 213 acres less than that proposed under Alternative A – FFD. Extraction of the gravel required for construction of Alternative B – FFD would impact a total of 287 acres of tundra and would require a total of 297 acres of ice pad for stockpiling overburden. Potential material source areas have not been identified..

Temporary ice roads and adjacent ice pads would cover approximately 2,739 acres of tundra over 20 winter seasons. Because Alternative B – FFD proposes a greater number of isolated HPs or HP clusters, ice road connections would need to be built each winter during the construction period. Therefore Alternative B – FFD would require construction of an additional 339 acres of ice roads relative to Alternative A – FFD. Elimination of road connections would reduce the number of bridges required for construction of Alternative B – FFD. Bridge locations have not been identified and therefore the area of ice pads associated with bridge construction cannot be quantified. However, it is assumed the number of bridges required under Alternative B – FFD would be less than the number required under Alternative A – FFD. Installation of 960 culverts and 13,044 VSMs under Alternative B – FFD would disturb approximately 19,900 and 46,500 cy of soil, respectively. Alternative B – FFD proposes to bury power cable in roads or in tundra between pads not connected by roads. Alternative B – FFD would require 48 miles of trenching in tundra to HP-11 and HP-15, and between HP-18 and HP-26 and HP-18 and HPF-1. Assuming a trench depth of 5 feet and width of 1-foot, this alternative would disturb 46,522 cy of active layer soils. Impacts associated with water discharges to the tundra and tundra travel during the construction period are assumed to be of the same magnitude as those under Alternative A – FFD.

OPERATION PERIOD

Reduction in road miles would minimize the indirect impacts associated with road travel and maintenance occurring during the operation period. Reduction of dust fallout and accumulations of plowed snow and sprayed gravel would minimize the thermal impacts to active layer soils and permafrost. The area of thermal impact calculated for Alternative B – FFD is 4,400 acres; 1,262 acres less than that for Alternative A – FFD. Quantification of thermal impact for Alternative B – FFD does not account for permafrost impacts due to trenching; an additional 5.8 acres would be disturbed by trenching. Operation period impacts associated with tundra travel, transmission of warm reservoir fluids, sub-permafrost injection of waste, and accidental oil spills occurring are assumed to be of the same magnitude as those under Alternative A – FFD.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON SOILS AND PERMAFROST

Construction and operation of Alternative B and Alternative B – FFD would result in a lesser impact to soil and permafrost resources, compared to Alternative A and Alternative A – FFD. Under Alternative B, 1,556 acres and 1.6 million cy of soil would be directly impacted compared to 1,757 acres and 2 million cy of soil estimated for Alternative A. The percent of the total Plan Area that would be impacted by construction under Alternative B is approximately 0.2 percent, which is an inconsequential impact.

Under Alternative B – FFD, approximately 4,085 acres and 7.6 million cy of soil would be directly impacted, compared to approximately 4,195 acres and 8.8 million cy of soil estimated for Alternative A – FFD. Alternative B – FFD would require a smaller surface disturbance than Alternative A – FFD due to the greater need for ice roads to support construction at isolated HPs. The percent of the total Plan Area that would be impacted by construction under Alternative B – FFD is 0.5 percent. Under Alternative B and Alternative B – FFD, the placement of fill on the tundra would represent the greatest direct impact to soil and permafrost; the thermal impacts associated with placement of fill on the tundra would represent the greatest indirect impact.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SOILS AND PERMAFROST

Soil and permafrost systems could recover to their pre-impact state, but not without appropriate mitigation. Because impacts to soil and permafrost are generally unavoidable, mitigation aims to minimize the degree and magnitude of the applicant’s proposed action. Mitigation measures proposed under Alternative B and Alternative B – FFD are the same as those identified for Alternative A (Section 4A.2.1.3). One specific recommendation under Alternative B is to run power cable in a tray supported by pipeline VSMs to avoid power cable burial and to reduce the degree and magnitude of impacts to soil and permafrost.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SOILS AND PERMAFROST

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.1.4 Sand and Gravel

Once used, sand and gravel resources for construction of roads, production pads, or airstrips may only be available for re-use upon abandonment.

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON SAND AND GRAVEL

CONSTRUCTION PERIOD

The estimated gravel volume required for Alternative B (Figure 2.4.2.1-1 and Table 2.4.2-3) is 1.6 million cy. Alternative B impacts to sand and gravel resources would be similar to, but less than, those identified for Alternative A.

OPERATION PERIOD

During the operation period, relatively small amounts of gravel are expected to be extracted from existing permitted mine sites for repair of road or pad embankments.

ABANDONMENT AND REHABILITATION

Sand and gravel impacts would be similar to those under Alternative A, although the use of approximately 20 percent less sand and gravel during construction would make this same amount unavailable for re-use.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SAND AND GRAVEL

The Alternative B – FFD would use and build off of the same road network that would be constructed under the Alternative B – CPAI Development Plan. Alternative B – FFD, depicted in Figure 2.4.2.2-1, is estimated to need 7.6 million cy (Table 2.4.2-5 and Table 2.4.2-6). Other than Clover, potential sources for this gravel have not yet been determined.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON SAND AND GRAVEL

Once used, sand and gravel resources for construction of roads, production pads, or airstrips may only be available for re-use upon abandonment. Removal of gravel fill is not currently a scheduled phase of abandonment.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SAND AND GRAVEL

No measures have been identified to mitigate impacts to sand and gravel resources under Alternative B nor Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SAND AND GRAVEL

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.1.5 Paleontological Resources

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON PALEONTOLOGICAL RESOURCES

Under Alternative B, the impacts to paleontological resources are generally the same as those under Alternative A, except that the intensity of the actions would decrease because of the elimination of road segments from CD-2 to CD-5 and CD-5 to CD-6. Excavation of sand and gravel material at the ASRC Mine Site and Clover could affect paleontological resources within approximately 37 acres of subsurface area. As for Alternative A, drilling, placement of gravel pads and VSMs, and bridge construction are very unlikely to impact paleontological resources.

Under Alternative B, powerlines would be buried in or under roads (in areas with roads) and in the tundra adjacent to the pipelines between pads in roadless areas. Because the occurrence of paleontological materials on the surface is isolated and rare, and route surveys would be completed before construction activities are started, the likelihood of impacts to paleontological resources during shallow trenching for powerlines is low.

Compared with Alternative A, Alternative B would require seven fewer vehicle bridges. The only bridge construction would be associated with a 40-foot vehicle bridge on the road segment between CD-6 and CD-7, and a 1,200-foot pipeline bridge across the Nigliq Channel. The only impact resulting from bridge construction would be associated with the placement of sheet piling at bridge abutments and with foundation piles at abutments and possibly in-stream locations. However, because route surveys are required for all construction activities, the location of important archaeological and paleontological resources would be known and would be avoided. Paleontological resources would not be impacted by abandonment activities.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PALEONTOLOGICAL RESOURCES

Under Alternative B – FFD, the mechanisms associated with impacts to paleontological resources would remain the same as those described under Alternative B, except that the intensity of the actions would increase as a result of the greater extent of the Plan Area. The primary potential cause of impacts would be excavation of gravel on approximately 287 acres. Approximately three gravel mine sites would be developed to provide the volume of construction material necessary for Alternative B – FFD. The location of gravel mine sites is yet unknown, but could be in areas that would affect paleontological resources. It is likely that the additional sand and gravel mine sites would be situated in the vicinity of the Fish–Judy Creeks and/or Kalikpik–Kogru Rivers

Facility Group. In addition, approximately 1,049 acres could be covered by gravel during the construction of production pads, roads, and airstrips.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON PALEONTOLOGICAL RESOURCES

Surface activities such as the construction of pad, road, and airfield embankments is not likely to affect paleontological resources. Impacts could result from those activities involving subsurface disturbance, such as sand and gravel mining. Installation of VSMs and bridge piles would occur only after route surveys had been conducted, so important paleontological resources would be known and avoided. Excavation of sand and gravel under approximately 37 acres under Alternative B – CPAI Development Plan and 287 acres under Alternative B – FFD would constitute the greatest risk to paleontological resources. This “greatest risk” represents inconsequential impact potential to paleontological resources.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PALEONTOLOGICAL RESOURCES

No measures have been identified to mitigate impacts to paleontological resources under Alternative B nor Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PALEONTOLOGICAL RESOURCES

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.2 Aquatic Environment

4B.2.2.1 Water Resources

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON WATER RESOURCES

Alternative B conforms completely to Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations. Stipulation 39 specifically minimizes impacts to water resources owing to setback requirements of permanent oil and gas facilities from water bodies. Thus, under Alternative B there are more airstrips, but no major stream crossings and the length of roads is significantly reduced.

Because there is not a road bridge across the Nigliq Channel, the Ublutuoch River, or other streams between CD-2 and CD-6 nor roads between these pads, there is less potential for erosion, sedimentation, or upslope impoundment associated with abandonment and rehabilitation activities under this alternative, compared to Alternative A.

GENERAL IMPACTS

In general, Alternative B would affect the same water resources (i.e., subsurface waters, lakes, creeks, rivers, and the nearshore environment) but to a lesser extent than Alternative A. The potential difference in impacts between the alternatives is primarily related to the presence of additional airstrips at CD-5 and CD-6, and the lack of any major stream crossing that would require a bridge for vehicular traffic. Pipeline bridges will be required at the Nigliq and Ublutuoch Crossings, but these would not need to be as large as those under Alternative A. Other than that, differences in impacts between the two alternatives can also be attributed to the locations of the impacts. Quantitative hydrologic analyses of Alternative B have not been made, so analyses are qualitatively based on the Alternative A analysis. Tables 4B.2.2-1 and 4B.2.2-2 provide summaries of potential construction and operation impacts to water resources under Alternative B in the general vicinities surrounding CD-3, CD-4, CD-5, CD-6, and CD-7, including the roads and pipelines connecting the facilitie (Section 4A.2.2.1).

TABLE 4B.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta Mouth	Harrison Bay
CD-3 and Vicinity											
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI	NI	7	6
Ice Roads	NI	NI	8,10	8,10	2,3	NI	NI	NI	2,3	2,3	NI
Airstrip	8	NI	NI	NI	2,3,4,5	NI	2,	2,3	2,3	6	6
Pipeline Segment: CD-1 to CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	NI	1,2,3	6	6
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

CD-4 and Vicinity							
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment CD-1 to CD-4	8	NI	NI	NI	2,7	2,3,4,5,6	**NI**
Pipeline Segment: CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	**NI**
Bridges	NI	NI	1,2,5	NI	2,3,4,5,6,7	2,3,4,5,6,7	**6**
Production Pad	8	NI	8	NI	NI	1,2,3,4,5,6	**NI**
Groundwater Wells	9	9	NI	NI	NI	NI	**NI**
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

TABLE 4B.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
CD-5 and Vicinity							
Gravel Segment: CD-5 to Airstrip	8	NI	NI	NI	NI	NI	NI
Ice Road and Bridge from CD-2 to CD-5	8	NI	8,10	8,10	2,3,4,5,6,7	2,3,4,5,6	NI
Airstrip	8	NI	NI	NI	NI	2,4,5,6	NI
Pipeline Segment: CD-2 to CD-5	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	8	NI	NI	2	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

CD-6 and Vicinity

	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI
Ice Roads	8	NI	8,10	8,10	NI	2,3,4,5,6,7	2,3,4,5,6	NI
Airstrip	8	NI	NI	NI	NI	NI	2,4,5,6	NI
Pipeline Segment: CD-5 to CD-6	NI	NI	NI	NI	NI	2,7	2, 7	NI
Production Pad	8	NI	8	NI	NI	NI	2	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

TABLE 4B.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Minor Streams	Harrison Bay
CD-7 and Vicinity							
Gravel Road Segment: CD-6 to CD-7	8	**NI**	2,5	2	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-6 to CD-7	NI	**NI**	NI	NI	NI	2, 7	NI
Production Pad	8	**NI**	8	NI	NI	2	NI
Groundwater Wells	9	**9**	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	**NI**	10	10	NI	NI	NI

Source:

Notes:

1 = Shoreline disturbance & thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages & velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

TABLE 4B.2.2-2 POTENTIAL OPERATIONS IMPACTS TO WATER RESOURCES

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT	
Colville River Facility Group	Shallow Groundwater	Deep Ground ater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3 and Vicinity											
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	5	NI	NI	NI	NI	NI	7	6
Ice Roads	NI	NI	10	10	NI	NI	NI	NI	NI	6	NI
Airstrip	8	NI	NI	5,6	2,3,	2,3	2,3	2,3	2,3	6	6
Pipeline Segment: CD-1 - CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	NI	2,3	6	6
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

CD-4 Area and Vicinity

	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment CD-1 to CD-4	8	NI	NI	NI	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	NI
Bridges	NI	NI	1,2,7	NI	NI	NI	NI
Production Pad	8	NI	8	NI	NI	2,3,4,5,6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

TABLE 4B.2.2-2 POTENTIAL OPERATIONS IMPACTS TO WATER RESOURCES (CONT'D)

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
CD-5 and Vicinity							
Gravel Segment: CD-5 to Airstrip	8	NI	NI	NI	NI	NI	NI
Ice Road and Bridge from CD-2 to CD-5	8	NI	NI	NI	4,5,6	4,5,6	NI
Airstrip	8	NI	NI	NI	NI	2,4,5,6	NI
Pipeline Segment: CD-2 -CD-5	NI	NI	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

CD-6 and Vicinity								
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI
Ice Roads	8	NI	NI	NI	NI	4,5,6	4,5,6	NI
Airstrip	8	NI	NI	NI	NI	NI	2,4,5,6	NI
Pipeline Segment: CD-5 to CD-6	NI	NI	NI	NI	NI	2, 7	2, 7	NI
Production Pad	8	NI	8	NI	NI	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

TABLE 4B.2.2-2 POTENTIAL OPERATIONS IMPACTS TO WATER RESOURCES (CONT'D)

Alternative B – CPAI Development Plan

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Minor treams	Harrison Bay
CD-7 and Vicinity							
Gravel Road Segment: CD-6 to CD-7	8	NI	NI	NI	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-6 to CD-7	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	1,7,8	NI	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Source:

Notes:

1 = Shoreline disturbance & thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages & velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

CONSTRUCTION IMPACTS

During the construction phase, ice roads and an ice bridge across the Nigliq Channel would be built to provide access to CD-5, CD-6, and CD-7. Withdrawal of water from lakes to construct the roads and bridge would not have long-term effects on the lakes since they sufficiently recharge on an annual basis. Although construction of ice roads and a bridge would not directly disturb streamflow processes (because they would be built in the winter), the subsequent melting of the structures would alter the hydrology of the basins, both in timing and magnitude of elevated discharge. Quantitative hydrologic analyses of the effect of the ice bridge and roads have not been conducted. It is possible that an ice bridge could constrict flow in the Nigliq Channel as it melts. Based on the results from hydrologic analyses of the Nigliq Bridge under Alternative A, constricted streamflow would increase localized velocity in the channel. Higher velocities would be expected in the ice bridge scenario under Alternative B as well. Water surface elevations upstream of the ice bridge are expected to increase until flow is no longer constricted. As discussed for Alternative A, localized scour during high and moderate-sized floods is a function of water flow patterns around the bridge. Under Alternative B, streamflow patterns would be dynamic as water passed the melting ice bridge. Accordingly, it is expected that localized scour and Delta sedimentation would occur. Nevertheless, the overall effect of this is considered negligible when considering the erosion and sedimentation processes within the channel and Delta.

Because there would be no permanent roads connecting the eastern and western production pads, CD-5 and CD-6 would be larger to allow for the staging of equipment and supplies. The larger footprint would compact a larger area of soil and reduce the recharge to the tundra (i.e., supra-permafrost zone) of the area. The difference in recharge is expected to be negligible when considered on a broader scale. CD-6 would be relocated just outside the 3-mile setback for Fish and Judy Creeks. Hence, the indirect construction impacts (e.g. entrainment of eroded/excavated sediments during break-up) on Fish–Judy Creek basin surface waters would be less under Alternative B than under Alternative A.

The pipeline bridge across the Nigliq Channel would result in less impacts to hydrology and channel features than a vehicle bridge, and these impacts would be negligable. Pipeline segments and gravel road segments between CD-5 and CD-6, and CD-6 and CD-7 would be positioned differently than they would under Alternative A but would result in similar construction impacts to water resources in their specific geographic locations.

OPERATION IMPACTS

The ice roads and ice bridges would only be built during the construction phase. Thus, there would not be an annual water supply demand for ice road and ice bridge operation. Water would be drawn from lakes for facility maintenance (e.g. dust mitigation), potable water, and fire suppression, but the quantity required for these operations is far less than what is required to maintain ice roads and bridges. There would not be long-term impacts associated with water withdrawal. However, if the requirement to use ice roads becomes and annual demand then the impacts to lake water resources would be much greater.

The operational impacts of Alternative B on water resources would be less than those under Alternative A because there are few permanent gravel roads. Figures 4A.2.2-2 and 4A.2.2-3 illustrate water surface elevations of existing facility conditions on the Delta during the 50-year and 200-year flood, respectively. Figures 4A.2.2-8 and 4A.2.2-9 illustrate water surface elevations influenced by Alternative A structures during the 50-year and 200-year flood, respectively. There is a difference in water surface elevations on either side of the proposed road that connects the eastern production pads, but this difference does not occur under the existing conditions scenario when a road is not present. Based on the model results from the existing conditions scenario, it is expected that natural drainage patterns under Alternative B would not be altered as much as they are under Alternative A and that water surface elevations from CD-4 to CD-6 would not vary (like they do under Alternative A) during low frequency flood events. Because natural drainage patterns would be altered less under Alternative B, channel scour and erosion in the Delta channels and minor streams, and resultant sedimentation in the Delta and Harrison Bay would be expected to be less.

The localized effect of the airstrips on water resources would be less than the effect of the long, continuous road because flow patterns would be disturbed less. Further, because CD-6 would be relocated outside of the 3-mile setback for Fish and Judy Creeks, local impacts, such as scour during flood events and sedimentation of the Fish–Judy basin, would decrease. Operation period impacts related to pipeline and gravel road segments between CD-5 and CD-6, and CD-6 and CD-7 would be similar to those under Alternative A, but would occur at a location specific to Alternative B.

While total pad and airstrip surface area increases under Alternative A, road surface area decreases, so the overall difference in runoff potential is minor or negligible.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON WATER RESOURCES

Alternative B – FFD is similar to Alternative A – FFD, except that HPF-1 would be eliminated from the Fish–Judy Creeks drainage basin and relocated to CD-9. Table 4B.2.2-3 provides a summary of potential construction and operation period impacts to water resources under Alternative B – FFD.

Stipulation 31 would set aside the Teshekpuk Lake Surface Protection Area—conformance would eliminate HP-22. This stipulation eliminates impacts to water resources to the Kogru River and other associated water bodies in the area of HP-22. In addition, under the Alternative B – FFD, several production pads would be relocated just outside the 3-mile setback on Fish and Judy Creeks (CD-6, HP-1, HP-16, and HP-17) in conformance with Stipulation 39. Stipulation 48 requires that no roads connect with road systems outside the Plan Area, which, among other things, results in a proposed vehicle bridge over the Nigliq Channel under this alternative.

Ice road construction under Alternative B – FFD would require up to 195 ac-ft per year of water to be withdrawn from lakes. The lengths of ice roads and the frequency of their construction would be higher under this alternative compared with Alternative A, in part because no gravel roads would be built across Fish Creek.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON WATER RESOURCES

In general, impacts to water resources under Alternative B would be similar but to a lesser extent than those under Alternative A. A reduction in the linear miles of roads would reduce potential impacts between CD-2 and CD-5, such as blockage of natural channel drainage, increased stages and velocities of floodwater, and channel scour. The use of ice roads, both under Alternative B – CPAI Development Plan and Alternative B – FFD would increase the demand for surface water, relative to Alternative A

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR WATER RESOURCES

Most of the data needs and mitigation measures recommended for Alternative A would also be applicable here. The exceptions would be the types, locations and amounts of data required related to stream crossings and bridge designs.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR WATER RESOURCES

The effectiveness of the protective measures would be similar to that under Alternative A.

TABLE 4B.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES

ALTERNATIVE B – FULL FIELD DEVELOPMENT

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS								ESTUARIES & NEARSHORE ENVIRONMENT	
Colville River Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Sakoonang Channel	Tamayayak Channel	Ulamnigiaq Channel	Elaktoveach Channel	Kupigruak Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3 and CD-4 and HPs 44, 5, 7, 8, 12, 13, and 14														
<u>Gravel Road Segments</u>: CD-3 to airstrip; CD-1 to CD-4; CD-2 to CD-5; CD-4 to HP-4; CD-2 to HP-5; HP-7 road to airstrip; HP-12 road to airstrip; HP-13 road to airstrip; HP-14 road to airstrip	8	NI	NI	NI	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4, 5,6,7	1,2,3,4,5, 6,7	NI
<u>Ice Roads</u>: CD-3, HP-7, HP-12, HP-13, and HP-14	NI	NI	10	10	NI	NI	3	3	3	3	3	3	1,2,3,4,5, 6,7	NI
<u>Pipeline Segment</u>: CD-3 to CD-1; CD-4 to CD-1; CD-5 to CD-2; HP-4 to CD-4; HP-5 to CD-2; HP-7 to CD-3/1 pipeline; HP-12 to HP-7; HP-13 to HP-12; HP-14 to HP-12	NI	NI	NI	NI	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,7	NI
<u>Production Pads</u>: All CDs and HPs	8	NI	8	8	2,3	2,3	2,3	2,3	2,3	2,3	NI	2,3	2,3	NI
<u>Airstrips</u>: CD-3, HP-7, HP-12, HP-13, and Hp-14														NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

TABLE 4B.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

ALTERNATIVE B – FULL FIELD DEVELOPMENT

	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT
Fish–Judy Creeks Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish Creek Basin	Inigok Creek Basin	Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
CDs 5, 6, and 7, HPF-1, and HPs 1, 2, 3, 6, 9, 10, 11, 15, 16, 17, and 19										
Gravel Road Segments: CD-5 to CD-6; CD-6 to CD-7; HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	8	NI	3,5,6,7	3,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI
Pipeline Segment: CD-6 to CD-5; CD-7 to CD-6; HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	NI	NI	2,7	2,7	2, 7	2,7	2,7	2,7	2,7	NI
Production Pads: All CDs, HPs and HPFs	8	NI	8	NI	2,3	2,3	2,3	2,3	2,3	NI
Processing Facility: HPF-1	8	NI	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI

TABLE 4B.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

ALTERNATIVE B – FULL FIELD DEVELOPMENT

	GROUNDWATER		**LAKES**		**MAJOR & MINOR STREAM CROSSINGS**			**ESTUARIES & NEARSHORE ENVIRONMENT**
Kogru–Kalikpik Rivers Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes & Ponds	Large Deep Lakes	Kalikpik River Drainage	Kogru River	Minor Streams	Harrison Bay
HPF-2 and HPs 18, 20, 21, and 22								
Gravel Road Segments: HP-18 to HPF-1; HP-19 to HPF-2/HP-18 road; HP-21 to HPF-2; HPF-2 to HP-18; HPF-2 road to airstrip	8	NI	3,5,6	3,5,6	2,3,4,5,6	NI	2,3,4,5,6	NI
Pipeline Segment: HP-18 to HPF-1; HP-20 to HPF-2/HP-18 road; HP-21 to HPF-2; HPF-2 to HP-18	NI	NI	NI	NI	2,7	NI	2,7	NI
Production Pads: All HPs and HPFs	8	NI	NI	NI	2,3,4,5,6	NI	2,3,4,5,6	NI
Airstrips: HPF-2	8	NI	NI	NI	3,4,5,6	NI	3,4,5,6,7	NI
Processing Facility: HPF-2	8	NI	NI	NI	3,4,5,6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

Notes:

1 = Shoreline disturbance & thermokarsting6 = Increased sedimentation

2 = Blockage of natural channel drainage7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)

3 = Increased stages & velocities of floodwater8 = Removal/compaction of surface soils/gravel and changes in recharge potential

4 = Increased channel scour9 = Underground disposal of non-hazardous wastes

5 = Increased bank erosion10 = Water supply demand

NI = No Impact

4B.2.2.2 Surface Water Quality

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON SURFACE WATER QUALITY

CONSTRUCTION PERIOD

Total water withdrawal volumes required for ice road construction would be approximately the same under Alternative B as under the applicant's proposed action over the 5-year construction period. Ice roads would be built to the same locations, with very slight differences in length due to the movement of CD-6 outside of the Fish Creek buffer. However, the lengths of ice roads to be constructed in later years would be higher for this alternative compared with Alternative A, because no gravel road would be built to CD-5. The estimated miles of ice roads required each year during construction vary from a minimum of 39 to a maximum of 68 (Table 2.4.2-2).

The chance that ice roads would be routed across lakes, potentially causing increased incidences of reductions in dissolved oxygen concentrations (as described for Alternative A) would be increased. Such a scenario could in turn affect fish over-wintering habitats. However, the likelihood of this impact occurring is very low. Lakes less than 7 feet-deep typically freeze solid during the winter, so there would be no concern about oxygen concentrations. Additionally, owing to safety considerations, ice roads are not typically routed over deep lakes due to concerns about unfrozen water and the possibility of cracking the road during transportation of heavy equipment.

Alternative B would involve the elimination of the gravel road between CD-6 and CD-5 for the applicant's proposed project. The reduction in total gravel placed in the Plan Area would reduce the potential impacts to water quality from increased turbidity caused by erosion and sedimentation, compared to Alternative A. Under Alternative B approximately 204 acres would be covered with gravel. This represents an 18 percent decrease in the gravel coverage estimated for Alternative B, compared to Alternative A. The area of tundra potentially affected by thermokarst erosion would be equivalent to twice the area directly covered by gravel or approximately 408 acres.

An additional source of thermokarst erosion under Alternative B would be the trenching required for burial of powerlines. The powerlines would parallel the route of the pipelines and would cover a distance of approximately 34 miles. Assuming a maximum trench width of 18 inches, the width of possible thermokarst erosion resulting from trenching would be approximately 3 feet. This would represent a potential area of disturbance of 4 acres.

OPERATION PERIOD

Dust fallout from roads would be expected to be lower for under Alternative B, compared to Alternative A, for two reasons. First, Alternative B restricts access to roads to industry. This would reduce the total number of vehicles traveling on the roads, although probably not by a measurable percentage. Second, this alternative would include construction of 11 miles of gravel roads for the applicant's proposed action, which represents a reduction from Alternative A of 56 percent. This reduction would be the only factor controlling the potential for impacts from upslope impoundments, flooding, and erosion because roads would be constructed in the same general areas (in terms of surface water flow) and would be constructed with the same design specifications (in terms of number and type of culverts).

ABANDONMENT AND REHABILITATION

Under Alternative B, because there is not a road bridge across the Nigliq Channel, the Ublutuoch River, or other streams between CD-2 and CD-6 or on roads between these pads, there is less potential for erosion, sedimentation, or upslope impoundment associated with abandonment and rehabilitation, than under Alternative A.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SURFACE WATER QUALITY

Ice road construction under Alternative B – FFD would require up to a maximum of 195 ac-ft of water to be withdrawn from lakes each year, based on the estimated miles of ice roads shown in Table 2.4.2-8. This is the same maximum annual volume of water withdrawal estimated under Alternative A. The lengths of ice roads would, on average, be higher for this alternative compared with Alternative A – FFD, because no gravel road would be built across Fish Creek. Because the total estimated miles of ice roads under Alternative B – FFD would be approximately 14 percent higher than under Alternative A, the chance that ice roads would be routed across lakes would increase. Such an increase could also increase incidences of reductions in dissolved oxygen concentrations (as described for Alternative A), which in turn could affect fish over-wintering habitats. However, the likelihood of this impact occurring is very low. Lakes less than 7 feet-deep typically freeze solid during the winter, so there would be no concern about oxygen concentrations. Additionally, owing to safety considerations, ice roads are not typically routed over deep lakes due to concerns about unfrozen water and the possibility of cracking the road during transportation of heavy equipment.

Alternative B – FFD would involve the elimination of several production pads and roads. The reduction in total gravel placed in the Plan Area would reduce the potential impacts to water quality from increased turbidity caused by erosion and sedimentation. Approximately 1,049 acres would be covered with gravel under Alternative B – FFD. . This represents an 17 percent decrease from the gravel coverage estimated under Alternative A. The area of tundra potentially affected by thermokarst erosion would be equivalent to twice the area directly covered by gravel, or approximately 2,098 acres.

Burial of the powerline also could cause thermokarst erosion. Based upon the calculations cited above for powerline burial impacts under Alternative B, Alternative B – FFD could prompt thermokarst erosion of 18 acres in an area about 3 feet-wide, over a length of 150 miles.

Dust fallout from roads would be expected to be lower for this alternative compared to Alternative A due to limited road access and use, and the construction of only a few miles of road. Under Alternative B – FFD, 94 miles of gravel roads would be constructed, which represents a reduction from Alternative A of 23 percent. This reduction would be the only factor controlling the potential for impacts from upslope impoundments, because roads would be constructed in the same general areas (in terms of surface water flow) and would be constructed with the same design specifications (in terms of number and type of culverts).

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON SURFACE WATER QUALITY

Alternative B proposes conducting all activities and siting all facilities in complete accordance with Northeast National Petroleum Reserve-Alaska IAP/EIS development stipulations. In comparison with Alternative A, this alternative would have fewer sources of potential impacts to surface water quality. This is mainly due to the movement of several production facilities outside sensitive resource areas and the reduction in total miles of roads to be constructed. Impacts would include:

- Decreased area potentially affected by thermokarst erosion compared to Alternative A, leading to decreased impacts to water quality from decreased turbidity caused by erosion and sedimentation

- Further distance from water bodies compared to Alternative A, reducing the chance of accidental releases migrating into a nearby water body

- Reduced potential for dust fallout and upslope impoundments compared to Alternative A, resulting in fewer incidences of turbidity impacts

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SURFACE WATER QUALITY

No mitigation measures have been identified for Alternative B nor Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SURFACE WATER QUALITY

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.3 Atmospheric Environment

4B.2.3.1 Climate and Meteorology

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON CLIMATE AND METEOROLOGY

CONSTRUCTION PERIOD

Construction period impacts to climate and meteorology under Alternative B would be similar to those described for Alternative A.

OPERATIONAL PERIOD

GHG impacts would be similar to those under Alternative A (Section 4A.2.3). Additional aircraft flights would occur due to operation of the additional airstrips, but would not change the overall impacts from GHG.

ABANDONMENT AND REHABILITATION

GHG impacts from would be similar to those under Alternative A (Section 4A.2.3).

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON CLIMATE AND METEOROLOGY

The impacts to climate and meteorology are similar to those under Alternative A – FFD. Additional airstrips would change the emission sources of GHG. The overall impact, however, would be minimal to the global GHG emissions budget.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON CLIMATE AND METEOROLOGY

The impacts are the same as those under Alternative A.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR CLIMATE AND METEOROLOGY

No mitigation measures have been identified.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR CLIMATE AND METEOROLOGY

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.3.2 Air Quality

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON AIR QUALITY

CONSTRUCTION PERIOD

Air quality impacts would be similar to those under Alternative A, with the exception of a potential decrease in of fugitive dust and particulates from construction of less acreage of gravel roads.

OPERATION PERIOD

Air emissions from the operational period of Alternative B would be the same as under Alternative A, except for minor short-term changes to air quality that may occur from differences in aircraft flights per month.

ABANDONMENT AND REHABILITATION

Impacts from abandonment and rehabilitation would be similar to those under Alternative A—short-term and transient.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON AIR QUALITY

The impacts to the airshed would not likely be significantly different than those under Alternative A, except for a slight reduction in emissions as a result of elimination of drill site heaters and emergency generators from pads that may not be constructed under Alternative B – FFD. Impacts would be determined by air quality impacts analysis under the PSD preconstruction review process.

Operation of the airstrips would change the nature of mobile source emissions from daily aircraft takeoffs and landings, instead of vehicular ground travel. However, emissions from the use of aviation fuel are considerably less than diesel fuel-powered mobile sources and would not add to deterioration in the overall air quality of the region.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON AIR QUALITY

Air quality impacts, including fugitive dust, from the project would be limited through the permitting process, which ensures that no significant new air pollution sources contribute to a deterioration of the ambient air quality. Mitigation measures for limiting fugitive dust would include road watering, vehicle washing, covering of stockpiled material, ceasing construction during wind events, and the use of chemical stabilizers. These measures may vary for the frozen season and non-frozen season. Dust may be reduced by utilizing sealing agents and chip-seal on pads, runways and heavily utilized portions o f the road system. Watering of dust-prone areas would also reduce dust associated with the project.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR AIR QUALITY

Air quality impacts from Alternative B would be limited through the permitting process, which ensures that no significant new air pollution sources contribute to deterioration of the ambient air quality. No additional measures have been identified.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR AIR QUALITY

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.2.3.3 Noise

ALTERNATIVE B – CPAI DEVELOPMENT PLAN NOISE IMPACTS

CONSTRUCTION PERIOD

Noise impacts during the construction period of Alternative B would be similar to those under Alternative A. Although two additional airstrips would be constructed, fewer roads would be constructed, and similar noise impacts would be distributed over the span of the construction period.

OPERATION PERIOD

Operation period noise impacts would be similar to those under Alternative A except for the short-term impacts of additional aircraft flights at the two additional airstrips.

ABANDONMENT AND REHABILITATION

Noise impacts would be similar to those associated with construction (minus drilling noise) and to Alternative A. The level of impact would be less than construction impacts under Alternative B if gravel fill is not removed.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO NOISE IMPACTS

The noise impacts would be similar to those described for Alternative A – FFD (Section 4A.2.3). There would be a reduction in drilling noise because there would be fewer production pads than under Alternative A.

ALTERNATIVE B – SUMMARY OF NOISE IMPACTS (CPAI AND FFD)

The impacts from Alternative B – CPAI Development Plan and Alternative B – FFD would be similar to the impacts described for Alternative A.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR NOISE

No potential mitigation measures have been identified for Alternative B nor Alternative B – FFD.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR NOISE

The effectiveness of the protective measures would be similar to that under Alternative A.

4B.3 BIOLOGICAL RESOURCES

4B.3.1 Terrestrial Vegetation and Wetlands

4B.3.1.1 Alternative B – CPAI Development Plan Impacts on Terrestrial Vegetation and Wetlands

The project design would minimize the facility footprints to reduce the loss of vegetation and habitat from gravel placement and associated indirect impacts. Biologists, geologists, facilities and reservoir engineers worked together combining information from waterbird distribution maps and wildlife habitat maps based on physical features (surface landforms, soil types, vegetation types) to locate facilities in drier habitats avoiding impacts to aquatic, Nonpatterned Wet Meadow, Patterned Wet Meadow, and Moist Sedge-Shrub Meadow habitats preferred by many waterbirds (CPAI 2004). Figure 4B.3.1-1 and Figure 4B.3.1-2 show vegetation and habitat potentially affected, and Table 4B.3.1-1 and Table 4B.3.1-2 summarize the area of vegetation classes and habitat types affected under the CPAI Development Plan, Alternative B. Terrestrial vegetation and wetlands impact calculation methods for CPAI's Alternatives A through F are described in Section 4A.3.1.1. All impacts under Alternative B would be to wetlands. Key wetland habitats correlated to those identified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b) are described in Section 3.3.1 and identified in Table 4B.3.1-2. Oil spills, should they occur, would also directly or indirectly affect vegetation and wetlands in the Plan Area. The impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

Section 2.7 (Table 2.7-1) for a comparison of impacts to tundra habitats in the Plan Area among alternatives.

CONSTRUCTION PERIOD

The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Gravel facilities would be designed and constructed as described in Section 2. Under Alternative B, a total of approximately 204 acres of tundra vegetation would be covered with gravel fill for the construction of pads (well pads and storage pads) (65.9 acres), approximately 10.7 miles of primary and spur roads (71.7 acres), and airstrip runways and aprons (64.1 acres). In addition to impacts from roads, pads, and airstrips, approximately 1.5 acres of tundra vegetation would be lost for the construction of a boat launch ramp at CD-4 and the associated access road, and a floating dock and access road at CD-3 as described in Section 2.3.8. Gravel facilities would be constructed and maintained to hold their designed dimensions; however, some gravel slumping from side-slopes could occur, which could potentially increase the impact area by approximately 16 percent (assuming a maximum increase from a 2H:1V to a 3H:1V sideslope). The type of impact from gravel slumping could range from direct loss of tundra vegetation to an alteration of vegetation communities depending on the thickness of gravel sloughed onto adjacent tundra. These potential impacts are included in the indirect impact area calculations from dust, gravel spray, snow accumulation, impoundments, and thermokarst discussed below. Vegetation classes and habitat types lost under Alternative B due to gravel placement are summarized in Tables 4B.3.1-1 and 4B.3.1-2, respectively.

Proposed gravel sources would be the same as those described under Alternative A. Gravel extraction for the construction of Alternative B would result in a permanent loss of approximately 37 acres of tundra habitat while the mine sites are active and an alteration from tundra to aquatic habitat when the gravel sites are reclaimed (Appendix O). The vegetation classes and habitat types affected by gravel extraction would be the same as those described under the CPAI Development Plan Alternative A.

The type of impacts from gravel facilities and mining and mitigation measures identified for these impacts would be the same as those described under CPAI's Development Plan Alternative A. Abandonment of roads, pads, and airstrips is discussed in Section 2.3.

DUST FALLOUT FROM ROADS

Under Alternative B, indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst would result in alteration of about 635 acres of tundra vegetation**,** assuming that these impacts occur within 164 feet (50 meters) of gravel facilities as described under CPAI's Development Plan Alternative A. Table 4B.3.1-1 and Table 4B.3.1-2 summarize the surface area by vegetation class and habitat types within this impact area. Compared to the other CPAI Development Plan alternatives proposed, Alternatives B and D would have the least amount of indirect impacts, including dust, because of their mostly roadless designs (i.e. Alternative B with slightly more impacts than Alternative D). The type of impacts from dust and associated mitigation measures would be the same as those described under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative B, a total of about 241 miles of temporary ice roads would be constructed over the life of the project for construction-related activities, resulting in a maximum of approximately 1,168 acres of vegetation disturbed. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year as required by existing stipulations on BLM-administered land. The actual surface area disturbed would likely be much less, especially if ice roads are overlapped in subsequent years to minimize the areal extent of impacts. Ice roads placed for the construction of gravel roads and pipelines would follow adjacent to the road/pipeline routes and would tend to affect the same habitat and vegetation (Table 4B.3.1-1 and Table 4B.3.1-2). Winter ice roads would be designed and located to minimize the breakage, abrasion, compaction, or displacement of vegetation.

In addition to ice roads, ice pads would be used as staging areas during pipeline construction. Approximately 70 acres of vegetation would be disturbed by ice pad staging areas for the construction of the pipeline. Ice pads might also be used to stockpile overburden material associated with the ASRC Mine Site and Clover. Impacts from these ice pads would be the same as those described under Alternative A. Ice pads also would be constructed at each end of each proposed bridge to stage equipment. These ice pads used as staging areas would vary with the size of the bridge installation and equipment needs. Given the number of road bridges proposed under Alternative B, and assuming the maximum pad size would be 800 feet by 800 feet surrounding the abutment structure at each end of a bridge (Section 2.3), then a maximum of 59 acres of vegetation would be affected by ice pads for bridge construction Ice pads could also be built for storage of drill rigs and other equipment at remote production pads. The effects of ice pads on vegetation would be similar in type to those of ice roads.

Less snow would need to be plowed under Alternative B than Alternatives A and C because fewer miles of road would be built. This would result in decreased alteration of vegetation by snow stockpiles. However, Alternative B would require slightly more snow plowing than Alternative D.

The type of impacts from ice roads, ice pads, and snow stockpiles and mitigation measures identified to minimize these impacts would be the same as those described under CPAI's Development Plan Alternative A.

TABLE 4B.3.1-1 CPAI ALTERNATIVE B – SUMMARY OF SURFACE AREA (ACRES) OF VEGETATION CLASSES AFFECTED

Vegetation Classes	COLVILLE RIVER DELTA								THE NATIONAL PETROLEUM RESERVE-ALASKA (WESTERN BEAUFORT COASTAL PLAIN)								Totals for Alternative B
	DIRECT IMPACTS					INDIRECT IMPACTS		Totals for Delta	DIRECT IMPACTS					INDIRECT IMPACTS		Totals fe NPRor th -A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal	Power Line Trenching		Primary Roads	Spur Roads	Well Pads	Storage Pad	Airstrip Runway & Apron	Dust, Moisture Regime, & Thermal	Power Line Trenching		
Water	1.1				<0.1	11.7	<0.1	12.8						3.5	0.1	3.6	16.4
Riverine Complex																	
Fresh Grass Marsh						1.6		1.6									1.6
Fresh Sedge Marsh									0.2					3.0	<0.1	3.2	3.2
Deep Polygon Complex				5.3		10.0	0.1	15.3									15.3
Young Basin Wetland Complex									2.1		2.5			14.5	<0.1	19.1	19.1
Old Basin Wetland Complex									1.7				2.0	26.1	0.3	30.2	30.2
Wet Sedge Meadow Tundra	9.6	1.6	21.9	11.0	0.1	116.4	0.7	161.4	3.4		6.3		5.6	36.9	0.3	52.5	213.9
Salt-killed Wet Meadow																	
Halophytic Sedge Wet Meadow						0.5		0.5									0.5
Halophytic Grass Wet Meadow																	
Moist Sedge-Scrub Tundra	9.0					60.8	<0.1	69.8	14.4	0.8	10.1	2.2	12.0	123.8	0.3	163.6	233.4
Tussock Tundra									21.2	0.7	14.6	7.8	28.2	194.8	0.4	267.7	267.7
Dryas Dwarf Shrub Tundra							<0.1										
Cassiope Dwarf Shrub Tundra															<0.1		
Halophytic Willow Dwarf Shrub Tundra																	
Open and Closed Low Willow Shrub	5.6				1.1	17.6	<0.1	24.4	0.4		0.7			4.2	<0.1	5.3	29.7

TABLE 4B.3.1-1 CPAI ALTERNATIVE B – SUMMARY OF SURFACE AREA (ACRES) OF VEGETATION CLASSES AFFECTED (CONT'D)

Vegetation Classes	COLVILLE RIVER DELTA								THE NPR-A (WESTERN BEAUFORT COASTAL PLAIN)								**Totals for Alternative B**
	DIRECT IMPACTS					INDIRECT IMPACTS		**Totals for Delta**	DIRECT IMPACTS					INDIRECT IMPACTS		**Totals for the NPR-A**	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal	Power Line Trenching		Primary Roads	Spur Roads	Well Pads	Storage Pad	Airstrip Runway & Apron	Dust, Moisture Regime, & Thermal	Power Line Trenching		
Open and Closed Tall Willow Shrub																	
Dune Complex																	
Partially Vegetated					0.2	9.2		9.4									9.4
Barrens						0.5	<0.1	0.5									0.5
Total Area	25.3	1.6	21.9	16.3	1.5	228.3	0.9	295.8	43.3	1.5	34.3	10.0	47.8	406.8	1.5	545.3	841.0

Notes:

Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.

Calculation methods are described in text in Section 4A.3.1.1.

Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

TABLE 4B.3.1-2 CPAI ALTERNATIVE B – SUMMARY OF SURFACE AREA (ACRES) OF HABITAT TYPES AFFECTED

Habitat Type	COLVILLE RIVER DELTA								The NPR-A (Western Beaufort Coastal Plain)								Totals for Alternative B
	DIRECT IMPACTS					INDIRECT IMPACTS		Totals for Delta	Direct Impacts					Indirect Impacts		Totals for the NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal	Power Line Trenching		Primary Roads	Spur Roads	Well Pads	Storage Pad	Airstrip Runway & Apron	Dust, Moisture Regime, & Thermal	Power Line Trenching		
Open Nearshore Water																	
Brackish Water																	
Tapped Lake with Low-water Connection																	
Tapped Lake with High-water Connection						1.0		1.0									1.0
Salt Marsh*						0.5		0.5									0.5
Tidal Flat*																	
Salt-killed Tundra*																	
Deep Open Water without Islands*						1.3	<0.1	1.3							<0.1		1.3
Deep Open Water with Islands or Polygonized Margins*	1.1					6.9	<0.1	8.0							<0.1		8.0
Shallow Open Water without Islands														1.8	<0.1	1.8	1.8
Shallow Open Water with Island or Polygonized Margins							<0.1							1.6	<0.1	1.6	1.6
River or Stream					<0.1	2.5		2.5									2.5
Aquatic Sedge Marsh									0.2					3.0	<0.1	3.2	3.2
Aquatic Sedge with Deep Polygons				5.3		10.0	0.1	15.3									15.3
Aquatic Grass Marsh*						1.6		1.6									1.6
Young Basin Wetland Complex*									2.1		2.5			14.5	<0.1	19.1	19.1

TABLE 4B.3.1-2 CPAI ALTERNATIVE B – SUMMARY OF SURFACE AREA (ACRES) OF HABITAT TYPES AFFECTED (CONT'D)

Habitat Type	COLVILLE RIVER DELTA								The NPR-A (Western Beaufort Coastal Plain)								Totals for Alternative B
	DIRECT IMPACTS					INDIRECT IMPACTS		Totals for Delta	Direct Impacts					Indirect Impacts		Totals for the NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal	Power Line Trenching		Primary Roads	Spur Roads	Well Pads	Storage Pad	Airstrip Runway & Apron	Dust, Moisture Regime, & Thermal	Power Line Trenching		
Old Basin Wetland Complex*									1.7				2.0	26.1	0.3	30.2	30.2
Riverine Complex*																	
Dune Complex																	
Nonpatterned Wet Meadow	0.8	0.8	7.6	1.8		24.7	0.2	36.0	2.0		5.9		0.2	20.9	<0.1	29.0	65.0
Patterned Wet Meadow	8.8	0.8	14.3	9.2	0.1	91.7	0.6	125.5	1.4		0.5		5.4	16.1	0.3	23.6	149.1
Moist Sedge-Shrub Meadow	9.0					60.8	<0.1	69.8	14.8	0.8	10.8	2.2	12.0	128.0	0.3	168.9	238.7
Moist Tussock Tundra									21.2	0.7	14.6	7.8	28.2	194.8	0.4	267.7	267.7
Riverine Low and Tall Shrub*															<0.1		
Upland Low and Tall Shrub																	
Upland and Riverine Dwarf Shrub*															<0.1		
Riverine or Upland Shrub*	5.6				1.1	17.6	<0.1	24.4									24.4
Barrens (riverine, eolian, or lacustrine)					0.2	9.7	<0.1	9.9									9.9
Artificial (water, fill, peat road)																	
Total Area	**25.3**	**1.6**	**21.9**	**16.3**	**1.5**	**228.3**	**0.9**	**295.8**	**43.3**	**1.5**	**34.3**	**10.0**	**47.8**	**406.8**	**1.5**	**545.3**	**841.0**

Notes:Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.

Calculation methods are described in text in Section 4A.3.1.1

Columns may not sum to exact numbers in the total row because of rounding, particularly when habitat types have impacts of <0.1.

* Represents key wetland habitats that were correlated to Bergman et al. (1977) habitats and riparian shrub habitats identified as key wetlands in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b)

OFF-ROAD TUNDRA TRAVEL

Development and operation of oil facilities in the Plan Area may require access across tundra. Such access could be necessary to respond to spills or other emergencies, conduct pipeline maintenance and repair, facilitate ice road construction, or to transport supplies and equipment to roadless development sites. The types of impacts to vegetation from off-road travel and associated mitigation measures would be similar to those described under Alternative A; however, impacts from off-road travel would presumably be the highest for Alternatives B and D because of the mostly roadless designs. Off-road travel impacts would likely be the lowest for Alternative C because all pads and most of the pipeline would be accessible by road. Off-road travel impacts of Alternative A would be slightly less than those of Alternative C.

IMPOUNDMENTS AND THERMOKARST

Indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst associated with roads, pads, and airstrips are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992); as described under CPAI's Development Plan Alternative A. Table 4B.3.1-1 and Table 4B.3.1-2 summarize the surface area of disturbance by vegetation classes and habitat types within this impact area. The types of impacts from impoundments and thermokarst and associated mitigation measures would be the same as those described under CPAI Development Plan Alternative A. Habitat alteration resulting from impoundments and thermokarst would be less extensive under Alternatives B and D because of the mostly roadless designs. The greatest amount of vegetation could potentially be affected by Alternative C because it proposes the highest number of road miles. The potential of Alternative A for impoundment and thermokarst impacts would be slightly less than for Alternative C.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts from the disruption of cross-drainage and interception of sheet flow and associated mitigation measures are described under Alternative A. Habitat alteration resulting from interception of natural water flow by gravel roads and pads would be less extensive under Alternatives B and D because of the mostly roadless designs. The greatest amount of vegetation could potentially be affected by Alternative C because it proposes the highest number of road miles. The potential for cross-drainage and water flow impacts would be slightly less for Alternative A than for Alternative C.

AIR POLLUTION

Project construction would cause a localized and temporary impact on air quality. The sources of air pollution during the construction period are described under Alternative A. These sources are not expected to produce sufficient levels of pollutants to adversely affect vegetation. Air quality mitigation measures would be the same as those described under Alternative A.

PIPELINES

Beside the disturbance from ice roads and staging pads for the construction of pipelines (discussed above), the only other impact to vegetation from pipeline construction under Alternative B is from VSM borings. Given the maximum diameter of VSM borings and the projected number of VSMs to be constructed under Alternative B (presented in Section 2.), and adding a 0.5-foot disturbance buffer to account for potential spoils and thermal impacts around the borings, about 0.5 acre of vegetation would be lost to VSM installation. The vegetation and habitat types affected would depend on the exact location of the VSM. An elevated pipeline design reduces impacts to vegetation and habitat types compared to buried pipeline designs.

POWER LINES

Under Alternative B, approximately 20 miles of trenching would be required to bury power cable in roadless areas between CD-1 and CD-3 and CD-2 and CD-6, affecting approximately 2.4 acres of tundra vegetation.

This area was calculated by overlaying a 1-foot wide strip centered on the pipelines (in areas where the power line is proposed to be buried in tundra) on vegetation and habitat maps (Figure 3.3.1.2-1 and Figure 3.3.1.3-1) (Jorgenson et al. 1997, 2003c) and calculating the area of impact for vegetation classes and habitat types within this strip. Table 4B.3.1-1 and Table 4B.3.1-2 summarize the surface area of disturbance by vegetation classes and habitat types within this impact area. To bury power cable along roadless segments a trench would be cut through an ice road, the power cable placed, and the cuttings pushed back into the trench. This would result in a temporary narrow strip of barren soil, which would become covered by vegetative reproduction as shoots from plants on either side of the trench recolonize the area (McKendrick 2000b). Wet sites recover more quickly than dry sites, and in ice rich soils thermokarst creates persistent linear features (McKendrick 2000b). Alternative B would have the greatest impact on vegetation compared to the other CPAI Development Plan alternatives that proposed suspended or VSM-mounted power lines (i.e. Alternatives A, C and D). Alternative B would have the greatest impact on vegetation from power line trenching. The entirely suspended power line design in Alternative C-1 would result in greater impacts than the other alternatives that propose partially suspended or VSM-mounted power lines (i.e. Alternatives A and D).

OPERATION PERIOD

The operation period includes continued drilling and day-to-day operations and maintenance once production has begun.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Additional vegetation losses following construction could occur during the operation period during maintenance of gravel roads (such as snow removal) or if flood events wash out portions of roads or pads and deposit gravel on tundra. The type of impacts to vegetation from these activities and events are described under the CPAI Development Plan Alternative A.

Impacts to vegetation resulting from maintenance of gravel roads and washouts would be less extensive under Alternatives B and D because of the mostly roadless designs. The greatest amount of vegetation could potentially be affected by Alternative C because it proposes the highest number of road miles. The impacts from maintenance of gravel roads and washouts in Alternative A would likely be slightly less than in Alternative C.

DUST FALLOUT FROM ROADS

During the operation period, effects of dust from roads, pads, and airstrips are expected to be realized within the 164-foot impact zone. The effects of dust on vegetation are described in the Construction Period section above. Table 4B.3.1-1 and Table 4B.3.1-2 summarize the surface area of disturbance by vegetation classes and habitat types within this impact area.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

In addition to ice roads required for construction-related activities, approximately 30 miles of ice roads would be needed for facility operations including well workovers and drilling activities at remote sites (CD-3, CD-5, and CD-6), resulting in approximately 145 acres of vegetation disturbed over the life of the facility. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year. The actual surface area disturbed would likely be much less, especially if ice roads are overlapped in subsequent years to minimize the areal extent of impacts. Ice roads placed for the construction of gravel roads and pipeline would follow adjacent to the road/pipeline routes and would tend to affect the same habitat and vegetation types (Table 4B.3.1-1 and Table 4B.3.1-2). Ice pads would not likely be needed during operations.

As during the construction period, snowdrifts or plowed snow would accumulate on tundra adjacent to roads, well pads, and airstrips. See the Construction Period discussion above for potential impacts.

OFF-ROAD TUNDRA TRAVEL

Some off-road tundra travel would continue during the operation period to respond to spills or other emergencies, to conduct pipeline maintenance and repair, to facilitate ice road construction, or to transport supplies and equipment to roadless development sites. See the Construction Period discussion above for potential impacts.

IMPOUNDMENTS AND THERMOKARST

Although there is a potential for some habitat loss and alteration to occur from thermokarst and the creation of impoundments during the operation period of the project, these impacts are more likely to be initiated during construction. Therefore, the factors causing vegetation loss and alteration are discussed above in the Construction Period section.

CROSS-DRAINAGE AND WATER FLOW

Disruption of cross-drainage and interception of sheet flow may continue to cause impacts to vegetation during the operational phase of this project. These impacts are initiated during the construction period and are discussed above.

AIR POLLUTION

Air pollution levels would increase during operations with the ACX upgrade of the existing APF-1 and increased emissions from traffic, drilling equipment, and well servicing and production equipment; however, this increase is not expected to generate levels of pollutants that would adversely affect vegetation. Air quality impacts caused by emissions from well servicing and drilling equipment would be intermittent and localized. Air quality mitigation measures would be the same as those described under Alternative A.

PIPELINES

Pipeline operation would not cause vegetation losses or alteration. However, occasional large-scale pipe repairs that may be required during the thawed season could result in additional tundra damage from equipment needed to conduct the repair work. Tundra travel is discussed above. Additionally, indirect impacts (discussed above in the Construction Period section) associated with snow drifting and shading would continue to occur during the operation period. Effects of pipeline spills on tundra are described in Section 4.3.

POWER LINES

No additional impacts to vegetation would occur from power lines during the operation period.

ABANDONMENT AND REHABILITATION

Impacts of abandonment under Alternative B would be similar in nature to that for Alternative A. However, because fewer miles of gravel roads would be created, none between CD-2 and CD-6 except for a short road associated with CD-5’s landing strip, the alteration in the vegetation and wetlands that could occur at abandonment would be correspondingly less.

4B.3.1.2 Alternative B – Full-Field Development Scenario Impacts on Terrestrial Vegetation and Wetlands

In addition to the impacts of CPAI Development Plan Alternative B, under the FFD scenario for Alternative B approximately 1,063 acres of tundra vegetation would be covered with gravel fill for the construction of pads (well pads, HPF pads, and storage pads), airstrips and associated aprons (474 acres), and 94 miles of roads (589 acres). Approximately 4,400 acres of vegetation would be indirectly affected by dust, gravel spray, snowdrifts, impoundments, and thermokarst. The effects of FFD on terrestrial vegetation and wetlands would depend on the location and extent of development in specific locations within each facility group. Table 4B.3.1-3 and Table 4B.3.1-4 summarize the estimated areas of vegetation classes affected under FFD Alternative B. Impact calculation methods for FFD are described in Section 4A.3.1.2. The type of direct and indirect impacts to vegetation related to gravel fill; dust fallout from roads; ice roads and snow stockpiles; off-road tundra travel; impoundments and thermokarst; cross-drainage and water flow; air pollution; pipelines; and power lines in the three facility groups (Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups) and proposed mitigation measures would be the same types as those described under CPAI Development Plan Alternative A.

COLVILLE RIVER DELTA FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under CPAI Development Plan Alternative B, approximately 217 acres of vegetation would be lost in the Colville River Delta Facility Group under FFD Alternative B for the construction of pads (hypothetical production pads HP-4, HP-5, HP-7, HP-8, HP-12, HP-13, and HP-14 and storage pads) and airstrips (164 acres) and connecting roads (53 acres) (Table 4B.3.1-3 and Table 4B.3.1-4). The dominant vegetation class in the vicinity of the Colville River Delta is Wet Sedge Meadow Tundra. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described previously for CPAI Development Plan Alternative A.

Gravel extraction for the hypothetical FFD would result in the destruction of approximately 287 acresof tundra vegetation. Specific gravel sources for the hypothetical FFD scenario have not been identified. The development process of any future gravel source would include planning, design, permitting, temporary staging areas, removal of overburden, blasting and excavation of gravel, and an approved rehabilitation plan. Analysis of impacts and appropriate mitigation measures would be examined before approval of future mine sites.

DUST FALLOUT FROM ROADS

Under FFD Alternative B, indirect impacts, including dust impacts, are expected to occur within 164 feet (50 meters) of gravel facilities as described in CPAI Development Plan Alternative A (Section 4A.3.1.1), resulting in alteration of about 656 acres of tundra vegetation in the Colville River Delta Facility Group (Table 4B.3.1-3 and Table 4B.3.1-4). The types of impacts to vegetation and mitigation measures associated with dust fallout would be the same as those described previously for CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under FFD Alternative B, ice roads would be necessary to access isolated pads and road segments every winter during construction and drilling, and periodically thereafter for well work over rig access and other maintenance and operations work. In the Colville River Delta Facility Group, approximately 165 miles of temporary ice roads would be constructed over the life of the project for FFD Alternative B, affecting approximately 800 acres of vegetation. The maximum area in the Colville River Delta Facility Group covered by ice roads in a single year would be 165 acres, with an average of 133 acres per year. As with CPAI Development Plan Alternative B, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above for CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described previously for Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potentially increased impacts to vegetation.

Table 4B.3.1-3 Alternative B – FFD Summary of Vegetation Impacts from Pads, Airstrips, Aprons, and Storage Pads

	Colville River Delta				**Fish-Judy Creek**				**Kalikpik-Kogru**			
			Direct Impacts	**Indirect Impacts**			**Direct Impacts**	**Indirect Impacts**			**Direct Impacts**	**Indirect Impacts**
Vegetation Classes	**Acres (%) in Colville Delta FFD Circles**		**Gravel (Acres)**	**Dust & Thermal (Acres)**	**Acres (%) in Fish-Judy Creek FFD Circles**		**Gravel (Acres)**	**Dust & Thermal (Acres)**	**Acres (%) in Kalikpik-Kogru FFD Circles**		**Gravel (Acres)**	**Dust & Thermal (Acres)**
Riverine Complex	0	(0.0%)	0.0	0.0	35	(0.1%)	0.2	0.3	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	56	(0.3%)	0.4	0.9	257	(0.6%)	1.3	2.2	49	(0.3%)	0.3	0.4
Fresh Sedge Marsh	3	(0.0%)	<0.1	<0.1	3,308	(7.9%)	17.2	28.4	1,296	(8.5%)	7.9	11.3
Deep Polygon Complex	550	(2.6%)	4.2	8.5	4,833	(11.6%)	25.2	41.5	1,417	(9.3%)	8.6	12.4
Young Basin Wetland Complex	0	(0.0%)	0.0	0.0	2,115	(5.1%)	11.0	18.2	650	(4.2%)	3.9	5.7
Old Basin Wetland Complex	0	(0.0%)	0.0	0.0	1,411	(3.4%)	7.4	12.1	0	(0.0%)	0.0	0.0
Wet Sedge Meadow Tundra	9,494	(44.1%)	72.2	147.2	8,951	(21.5%)	46.7	77.0	5,987	(39.1%)	36.4	52.4
Salt-killed Wet Meadow	1,633	(7.6%)	12.4	25.3	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	1,210	(5.6%)	9.2	18.8	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	32	(0.1%)	0.2	0.5	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Shrub Tundra	782	(3.6%)	5.9	12.1	3,308	(7.9%)	17.2	28.4	0	(0.0%)	0.0	0.0
Tussock Tundra	139	(0.6%)	1.1	2.2	14,864	(35.7%)	77.5	127.8	5,120	(33.4%)	31.1	44.8
Dryas Dwarf Shrub Tundra	29	(0.1%)	0.2	0.5	104	(0.3%)	0.5	0.9	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	371	(0.9%)	1.9	3.2	238	(1.6%)	1.4	2.1
Halophytic Willow Dwarf Shrub Tundra	8	(0.0%)	0.1	0.1	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	1,929	(9.0%)	14.7	29.9	301	(0.7%)	1.6	2.6	1	(0.0%)	<0.1	<0.1
Open and Closed Tall Willow Shrub	0	(0.0%)	0.0	0.0	23	(0.1%)	0.1	0.2	0	(0.0%)	0.0	0.0
Dune Complex	0	(0.0%)	0.0	0.0	638	(1.5%)	3.3	5.5	113	(0.7%)	0.7	1.0
Partially Vegetated	1,183	(5.5%)	9.0	18.4	334	(0.8%)	1.7	2.9	130	(0.8%)	0.8	1.1
Barrens	4,487	(20.8%)	34.1	69.6	838	(2.0%)	4.4	7.2	311	(2.0%)	1.9	2.7
Totals	**21,536**	**(100.0%)**	**163.7**	**334.0**	**41,692**	**(100.0%)**	**217.3**	**358.4**	**15,312**	**(100.0%)**	**93.0**	**134.0**

Notes:Calculation methods are described in text in Section 4A.3.1.2.

Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

TABLE 4B.3.1-4 ALTERNATIVE B – FFD SUMMARY OF VEGETATION IMPACTS FROM ROADS

	Colville River Delta				Fish-Judy Creek				Kalikpik-Kogru River			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
Vegetation Classes	**Acres (%) in Colville Delta Road Buffer**		**Gravel (Acres)**	**Dust & Thermal (Acres)**	**Acres (%) in Fish-Judy Creek Road Buffer**		**Gravel (Acres)**	**Dust & Thermal (Acres)**	**Acres (%) in Kalikpik-Kogru Road Buffer**		**Gravel (Acres)**	**Dust & Thermal (Acres)**
Riverine Complex	15	(0.3%)	0.1	0.8	38	(0.1%)	0.4	2.7	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	63	(1.1%)	0.6	3.6	2,105	(7.3%)	24.9	151.1	650	(6.5%)	12.5	76.1
Fresh Sedge Marsh	0	(0.0%)	0.0	0.0	229	(0.8%)	2.7	16.4	0	(0.0%)	0.0	0.0
Deep Polygon Complex	39	(0.7%)	0.4	2.3	76	(0.3%)	0.9	5.4	18	(0.2%)	0.3	2.1
Young Basin Wetland Complex	43	(0.8%)	0.4	2.5	3,164	(10.9%)	37.4	227.1	714	(7.2%)	13.8	83.6
Old Basin Wetland Complex	95	(1.7%)	0.9	5.5	1,123	(3.9%)	13.3	80.6	105	(1.1%)	2.0	12.3
Wet Sedge Meadow Tundra	2,958	(53.5%)	28.4	172.3	5,695	(19.6%)	67.3	408.8	1,254	(12.6%)	24.2	146.8
Salt-killed Wet Meadow	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	3	(0.1%)	<0.1	0.2	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	5	(0.1%)	<0.1	0.3	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Scrub Tundra	702	(12.7%)	6.7	40.9	2,372	(8.2%)	28.0	170.3	206	(2.1%)	4.0	24.2
Tussock Tundra	442	(8.0%)	4.2	25.7	5,625	(19.4%)	66.5	403.8	3,367	(33.7%)	64.9	394.3
Dryas Dwarf Shrub Tundra	3	(0.0%)	<0.1	0.2	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	231	(4.2%)	2.2	13.4	7,787	(26.8%)	92.0	558.9	3,238	(32.4%)	62.4	379.2
Halophytic Willow Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	517	(9.4%)	5.0	30.1	615	(2.1%)	7.3	44.1	283	(2.8%)	5.5	33.1
Open and Closed Tall Willow Shrub	0	(0.0%)	<0.1	<0.1	35	(0.1%)	0.4	2.5	1	(0.0%)	<0.1	0.1
Dune Complex	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Partially Vegetated	140	(2.5%)	1.3	8.2	103	(0.4%)	1.2	7.4	34	(0.3%)	0.7	4.0
Barrens	272	(4.9%)	2.6	15.9	60	(0.2%)	0.7	4.3	110	(1.1%)	2.1	12.9
Totals	**5,526**	**(100.0%)**	**53.0**	**321.8**	**29,027**	**(100.0%)**	**343.0**	**2,083.5**	**9,979**	**(100.0%)**	**192.4**	**1,168.6**

Notes:Calculation methods are described in text in Section 4A.3.1.2.

Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under CPAI Development Plan Alternative A. Under FFD Alternative B, the surface area affected would be expected to increase because of the increased length of pipeline and roads and the number of remote facilities that could require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

Indirect impacts from dust and changes to moisture or thermal regimes associated with roads, pads, and airstrips are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992), as described under CPAI's Development Plan Alternative A. Table 4B.3.1-3 and Table 4BA.3.1-4 summarizes the surface area of disturbance by vegetation class within this impact area for each facility group. The types of impacts to vegetation associated with thermokarst and ponding and the proposed mitigation measures for these impacts would be the same as those described above for CPAI Development Plan Alternative A.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with disruption of cross-drainage and interception of sheet flow would be the same as those described previously for CPAI Development Plan Alternative A. These impacts would be greatest in the vicinity of the Colville River Delta because of unstable flow regimes and ocean-induced storm surges. In addition, roads would likely cross many ephemeral streams in the Colville River Delta area, and culverts would need to be installed. Gravel placement could potentially disturb sheet flow in the spring and could affect local moisture regimes. Culverts allow surface water flow, but they tend to ice-up and increase flow in a small area relative to typical sheet flow. Alteration of sediment disposition patterns during flood events may occur due to obstructions from roads and redirection of floodwaters through culverts. These changes may result in alteration of vegetation succession and long-term alteration of habitat types.

AIR POLLUTION

No additional processing facilities would be built in the Colville River Delta Facility Group under FFD Alternative B; however, the increased amount of vehicles and equipment associated with the production pads and roads would potentially cause a greater increase in air pollution. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

In addition to the impacts from CPAI Development Plan Alternative B, a total of approximately 1.8 acres of vegetation would be lost to VSM installation under the FFD scenario for Alternative B, of which about 0.4 acre would occur in the Colville River Delta Facility Group. The vegetation and habitat types affected would depend on the exact location of the VSM, which are generally spaced at 55 to 65 foot intervals. The types of impacts to vegetation associated with snow drifting or shading from the aboveground pipelines would be the same as those described previously for CPAI's Development Plan Alternative A.

POWER LINES

Under FFD Alternative B, power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

FISH-JUDY CREEKS FACILITY GROUP

In addition to habitat loss described under CPAI Development Plan Alternative B, approximately 560 acres of vegetation would be lost in the Fish-Judy Creeks Facility Group under FFD Alternative B for the construction of pads (a processing facility; well pads HP-1, HP-3, HP-6, HP-9, HP-10, HP-11, HP-15, HP-16, HP-17, and HP-19; and storage pads) and airstrips (217 acres) and connecting roads (343 acres) (Table 4A.3.1-3 and Table 4A.3.1-4). The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described previously for CPAI Development Plan Alternative A.

DUST FALLOUT FROM ROADS

Under FFD Alternative B, indirect impacts, including dust impacts, would result in alteration of about 2,442 acres of tundra vegetation in the Fish-Judy Creeks Facility Group (Table 4B.3.1-3 and Table 4B3.1-4). The types of impacts to vegetation and mitigation measures associated with dust fallout would be the same as those described previously for CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative B for FFD in the Fish-Judy Creeks Facility Group, approximately 276 miles of temporary ice roads would be constructed over the life of the project, affecting about 1,338 acres of vegetation. The maximum area covered by ice roads in the Fish-Judy Creeks Facility Group in a single year would be 213 acres, with an average of 134 acres per year. As with the CPAI Development Plan Alternative B, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described for CPAI Development Plan Alternative A. Under FFD Alternative B, the surface area affected would be expected to increase because of the increased length of pipeline, roads, and number of remote facilities that could require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding and the proposed mitigation measures for these impacts would be the same as those described previously for CPAI Development Plan Alternative A. The construction of more roads and pads under the FFD scenario could potentially result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within the 164-foot impact zone as described in CPAI Development Plan Alternative A (Section 4A.3.1.1). Table 4B.3.1-3 and Table 4B.3.1-4 summarize the potential surface area of disturbance by vegetation class within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described previously for CPAI Development Plan Alternative A, although the construction of more roads and culverts under the FFD scenario could potentially cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Fish-Judy Creeks Facility Group would result in a localized increase of air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

Under the FFD scenario for Alternative B, approximately 1.1 acres of vegetation would be lost in the vicinity of the Fish-Judy Creeks Facility Group by VSM placement.

POWER LINES

Under FFD Alternative B, power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

In addition to habitat loss described for CPAI Development Plan Alternative B, approximately 285 acres of vegetation would be lost in the Kalikpik-Kogru Rivers Facility Group under FFD Alternative B for the construction of pads (a hypothetical processing facility; production pads HP-18, HP-20, and HP-21; and storage pads) and airstrips (93 acres) and connecting roads (192 acres) (Table 4B.3.1-3 and Table 4B.3.1-4). The dominant vegetation classes in the Kalikpik-Kogru Rivers Facility Group are Tussock Tundra and Sedge Grass Meadow. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described previously for CPAI Development Plan Alternative A.

DUST FALLOUT FROM ROADS

Under FFD Alternative B, indirect impacts, including dust impacts, would result in alteration of about 1,303 acres of tundra vegetation in the Kalikpik-Kogru Rivers Facility Group (Table 4B.3.1-3 and Table 4B3.1-4). The types of impacts to vegetation and mitigation measures associated with dust fallout would be the same as those described previously for CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative B for FFD in the Kalikpik-Kogru Rivers Facility Group, approximately 180 miles of ice roads would be constructed over the life of the project, affecting about 873 acres of vegetation. The maximum area covered by ice roads in the Kalikpik-Kogru Rivers Facility Group in a single year would be 305 acres, with an average of 218 acres per year. As with the CPAI Development Plan Alternative B, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described for CPAI Development Plan Alternative A. Under FFD Alternative B, the surface area affected would be expected to increase because of the increased length of pipeline, roads, and number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding and the proposed mitigation measures for these impacts would be the same as those described previously for CPAI Development Plan Alternative A. Under FFD Alternative B, the construction of more roads and pads would result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Table 4B.3.1-3 and Table 4B.3.1-4 summarize the potential surface area of disturbance by vegetation class within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described previously for CPAI Development Plan Alternative A, although the construction of more roads and culverts under FFD Alternative B would cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Kalikpik-Kogru Rivers Facility Group would result in a localized increase in air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

Under the FFD scenario for Alternative B, approximately 0.4 acre of vegetation would be lost in the Kalikpik-Kogru Rivers Facility Group from VSM placement. The types of impacts to vegetation associated with snow drifting or shading from pipeline placement would be the same as those described above under the CPAI Development Plan Alternative A.

POWER LINES

Under FFD Alternative B, power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

4B.3.1.3 Alternative B – Summary of Impacts (CPAI and FFD) on Terrestrial Vegetation and Wetlands

Impacts from CPAI Development Alternative B to vegetation and habitat types are summarized in Tables 4B.3.1-1 and 4B.3.1-2, respectively. Impacts from FFD Alternative B are summarized in Table 4B.3.1-3 and Table 4B.3.1-4.

Vegetation maps cover the entire Plan Area, and detailed wildlife habitat maps are available for the entire area affected by CPAI's proposed Alternative B (Figure 4B.3.1-2). Vegetation classes and wildlife habitat types are cross-referenced in Table 3.3.1-3. Summary of impacts are presented as percentages of available vegetation type or habitat class within the Colville River Delta or the National Petroleum Reserve-Alaska portions of the Plan Area. Wildlife habitat mapping covers 100 percent of the Colville River Delta, 24 percent of the National Petroleum Reserve-Alaska portion of the Plan Area, and 37 percent of the total Plan Area.

Under CPAI Alternative B, approximately 241 acres of tundra vegetation would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 2,116 acres would be altered or disturbed by ice roads and pads, dust, snow accumulation, power line trenching, and changes to thermal or moisture regimes; combined representing less than one percent of the Plan Area (Table 4B.3.1-1 and Table 4B.3.1-2).

In the Colville River Delta portion of the Plan Area, the highest surface area impacts are to Wet Sedge Meadow Tundra vegetation (161 acres lost or altered; 0.4 percent of available in the area) and Patterned Wet Meadow habitat (126 acres lost or altered; 0.4 percent of available in the area). In the National Petroleum Reserve-Alaska portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (268 acres lost or altered; 0.1 percent of available in the area) and Moist Tussock Tundra habitat (268 acres lost or altered; 0.5 percent of available mapped habitat in the area) (Tables 4B.3.1-1 and 4B.3.1-2).

Under CPAI Alternative B, key wetland habitats that would be lost or altered in the 146,637 acre Colville River Delta are: riparian shrubland (24 of 7,575 acres); aquatic grass marsh (1.6 of 369 acres); deep open lakes (9.3 of 7,810 acres); basin-complex wetlands (0 of 2 acres); and coastal wetlands (0.5 of 29,022 acres). Key wetland habitats that would be lost or altered in the 175,153 acres mapped in the National Petroleum Reserve-Alaska are: riparian shrubland (<0.1 of 4,741 acres); aquatic grass marsh (0 of 501 acres); deep open lakes (<0.1 of 22,374 acres); basin-complex wetlands (49 of 16,297 acres); and coastal wetlands (0 of 36 acres). Thus, impacts to all key wetlands, including those that contain *Arctophila* and *Carex aquatilis*, will be minor.

Under FFD Alternative B, approximately 1,336 acres of tundra vegetation (less than one percent of the Plan Area) would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 9,031 acres (less than one percent of the Plan Area) would be altered or disturbed by ice roads, dust, and changes to thermal or moisture regimes (Table 4B.3.1-3 and Table 4B.3.1-4). Habitat types were not assessed for FFD because habitat mapping does not cover the entire Plan Area (Figure 3.3.1.3-1) (Jorgenson et al. 2003c).

4B.3.1.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Terrestrial Vegetation and Wetlands

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.3.1.4).

4B.3.1.5 Alternative B – Effectiveness of Protective Measures for Terrestrial Vegetation and Wetlands

The effectiveness of the protective measures would be similar to Alternative A.

4B.3.2 Fish

As in Alternative A, the primary concern in the Plan Area is maintaining winter habitat for fish. Maintaining suitable feeding and spawning areas and access to these areas, which are often in different geographic locations; water withdrawal; alteration of flow patterns; release of contaminants during the life of the project; and the impacts of oil spills are likewise of concern.

Impacts of and measures to prevent, control, and mitigate spills are addressed in Section 4.3. Furthermore, that section includes an assessment of the effects of the project on marine fish and habitats. Normal construction and operation impacts for this alternative would not be expected to have measurable effects on Harrison Bay and nearshore Beaufort Sea environments and biota. Essential Fish Habitat is discussed in Section 4B.3.2.3.

4B.3.2.1 Alternative B – CPAI Development Plan Impacts on Fish

The CPAI Development Plan Alternative B (Figure 2.4.2.1-1) differs from Alternative A in that the project is designed to attain complete conformance with the Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations as presented in the 1998 ROD (BLM and MMS 1998b). The primary differences include (1) moving the location of production pad CD-6 and the associated pipeline outside the 3-mile sensitive area surrounding Fish Creek (as designated by BLM and MMS 1998a); (2) eliminating the Nigliq Channel road bridge; (3) eliminating the entire road between CD-2 and CD-6; and (4) constructing airstrips at production pads CD-5 and CD-6.

The impacts of Alternative B are largely the same as those of Alternative A discussed in Section 4A.3.2.1. Major differences from Alternative A are addressed in the following text.

CONSTRUCTION PERIOD

The construction of Alternative B would not result in any significant obstructions to fish movements. Fish would not be present in the affected areas during winter.

WATER WITHDRAWAL

The main potential impacts of Alternative B would be related to winter water withdrawal from fish-bearing lakes, as described in Section 4A.3.2. Impacts are not expected if withdrawals are conducted in compliance with permit requirements. The necessary water withdrawals would be monitored to ensure that the volume of water removed from any lake does not exceed permitted amounts. Potential water sources (i.e., for ice roads) would be the same lakes as described under Alternative A (see Figure 4A.3.2-1 and Figure 4B.3.2-1).

GRAVEL MINING

Impacts of gravel mining are as described in Section 4A.3.2, although they would be reduced compared to Alternative A because of a reduced need for gravel under this alternative.

PIPELINES

Impacts of pipeline installation would be generally the same as those for Alternative A (Section 4A.3.2). A pipeline crossing of or a pipeline bridge over the Nigliq Channel would be required. A pipeline-only bridge would carry a significantly smaller load, enabling a span of much greater distance as compared to a road bridge.

PADS AND AIRSTRIPS

The airstrip at CD-5 would be built on higher ground near the production pad and does not appear to impinge on any lakes or wetlands potentially used by fish (Figure 2.4.1.1-8 for detail near CD-5).

Likewise, the production pad and airstrip at CD-6 would be situated on high ground and would not impinge on any fish habitat. The location of this pad and airstrip outside of the sensitive area surrounding Fish Creek would minimize the possibility of impacts to that sensitive habitat.

In Alternative B, the road and pipeline corridors to CD-7 are somewhat shorter than the corresponding features of Alternative A and are outside the sensitive habitat around Fish Creek. No winter fish habitat would be affected, nor would any in-stream channel work be required.

BRIDGES AND ROADS

Impacts of road construction would be similar to those of Alternative A (Section 4A.3.2), but they would affect a much smaller area.

There would be a 40-foot bridge over the narrow neck of Lake 9323 (Figure 2.4.2.1-1 and Figure 4B.3.2-1) just north of CD-4. This would eliminate potential impacts of culvert installation described in Section 4A.3.2.

The Nigliq Channel road bridge would not be constructed. A favorable consequence relative to Alternative A is that the need for midstream support piers would be eliminated along with the potential construction impacts to the Nigliq Channel as described in Section 4A.3.2.

Similarly, no road bridge would be needed at the Ublutuoch River, and no impacts from pipeline construction would be expected at this site.

The roads and bridges from CD-2 to CD-5 and from CD-5 to CD-6 would not be constructed, and the associated impacts as described in Section 4A.3.2 would not occur. CPAI would still build ice roads for winter construction of the pipeline from CD-2 to CD-6.

A road bridge would still be required east of CD-7 (Figure 2.4.2.1-1), as in Alternative A (Section 4A.3.2).

CULVERTS

No culverts have been proposed for Alternative B. Impacts of culverts, if installed, would be as described in Section 4A.3.2.

BOAT RAMPS AND DOCKS

Construction of boat ramps and docks, should any be needed for spill response purposes, may have in-stream impacts similar to those of bridge construction.

POWER LINES

Wherever there are roads, power lines would be buried in or under roads or at the toe of the road slope. There should be no incremental impacts to fish beyond those described for roads (Section 4A.3.2).

Where there are no roads, power lines would be buried in the tundra adjacent to the pipeline. They would be hung off pipeline bridges at stream crossings and trenched across minor drainages. Because trenching would occur in winter when these waters would be frozen and no fish would be present, no impacts to fish would be expected

OPERATION PERIOD

ROADS AND PIPELINES

Operation of the pipeline in Alternative B would have effects similar to those described in Section 4A.3.2. Impacts from low-ground-pressure vehicles needing emergency access in roadless areas when the ground is not frozen could potentially occur between CD-1 and CD-3 and between CD-2 and CD-6.

The pipeline corridor would have minimal effects on fish habitat. No in-channel structures are contemplated. In particular, the VSMs on which the pipeline over the Nigliq Channel would be mounted would not result in alteration or loss of habitat nor obstruction of fish passage.

PADS, ROADS, AND AIRSTRIPS

Operation of airstrips, production pads, and the roads in Alternative B would have impacts similar to those of Alternative A (Section 4A.3.2); however, they would be on a smaller scale because of the shorter length of roads proposed for Alternative B. Because of the shorter length of roads proposed for Alternative B, the potential for flow alteration on a landscape scale would be smaller relative to Alternative A.

Production pad CD-6 is reasonably close to, but upstream of Lake M9925 (Figure 4B.3.2-1). This tundra lake is about 4 feet deep and has been documented to contain ninespine sticklebacks during summer. In Alternative B, CD-6 is located outside the sensitive area as designated by the BLM and MMS (1998a) in the Fish Creek drainage and farther away from Fish Creek—a very important fish habitat. This should reduce the potential for contaminants to reach this important habitat.

BRIDGES

Operation of the two proposed 40-foot bridges would not be expected to have any effects on fish. Because the Nigliq Channel road bridge would not be built, the potential for the disruptive effects of gravel road approaches to the bridge would be eliminated.

CULVERTS

Culverts, should they be installed, would be designed to maintain adequate water flow and fish passage. The nature of the potential impacts of installed culverts would be as described in Section 4A.3.2. Because of the shorter length of roads proposed for Alternative B, there potentially would be fewer culverts, and thus a lower impact potential than in Alternative A.

HUMAN ACCESS

Issues associated with and impacts of human access would be generally as described for Alternative A (Section 4A.3.2). The presence of ice roads during winter might encourage local fisherman to fish the Ublutuoch fish overwintering area, despite these roads being closed to local residents in Alternative B. This could result in a more than negligible increase of fishing pressure on overwintering fishes.

ABANDONMENT AND REHABILITATION

Impacts to fish from abandonment and rehabilitation activities would be similar, but less than those resulting from Alternative A primarily because there would be no road bridges over the Nigliq Channel or Ublutuoch River, or road with smaller bridges or culverts between CD-2 and CD-6 to be removed.

4B.3.2.2 Alternative B – Full-Field Development Impacts on Fish

Types of impacts of future development in the Plan Area generally will be similar to those described above for the five-pad CPAI Development Plan Alternative B (Section 4A.3.2). However, development on the scale postulated will, depending on precise siting, destroy or alter fish habitat substantially more than CPAI’s proposed project. Overwintering, rearing, migration, and spawning habitats would be affected.

The road and pipeline network would create subtle alteration of flows of waterways on a landscape scale that could lead to unexpected shifts in drainage and loss of fish resources. Overall, the extent of roads has been substantially reduced from Alternative A; thus the extent of impacts would be proportionally reduced. Impacts to fish passage would be minimized by installation of culverts or bridges as determined during future permitting efforts. However, failure of any culverts that might be installed (Section 4A.3.2) could cause widespread habitat alteration and obstruction of fish movement.

The extent of road development under this scenario suggests that there should be increased potential for human access to fish resources throughout the ASDP Area, thus creating greater pressure on fish populations. However, road access would be allowed for industry only, and no gravel roads would cross the Fish and Judy creek drainages between HPF-1 and HP-18. Conversely, some traditional users of the area may choose other locations to avoid industrial activity altogether.

State-of-the-science construction and operation approaches would be used to minimize impacts, and human access to resources could be controlled as described in Section 4A.3.2. Withdrawal of fresh water necessary to support this scale of infrastructure development, plus well drilling, should not affect fish if withdrawals are done in compliance with permit restrictions. The cumulative effects of this FFD scenario are expected to be similar to effects from current developments. Future mitigation measures are expected to be successful, based on the impacts of previous projects to fish habitat and passage.

The following subsections summarize concerns specific to the three facility groups.

COLVILLE RIVER DELTA FACILITY GROUP

In the Colville River Delta, seven new production pads are hypothesized. Of particular note are production pads HP-12 and HP-14 on the eastern side of the outer Colville River Delta, which are in vicinity of the commercial (Helmericks) fishery as well as subsistence fisheries. Spills, addressed in Section 4.3, would be of major concern with these two hypothetical facilities.

No roads are hypothesized in this part of the Plan Area except short pad-airstrip roads and the road from CD-4 to HP-4. Pipelines would be constructed over several major watercourses including the Elaktoveach Channel, Kupigruak Channel, Tamayayak Channel, and the main stem of the Colville River. In-stream construction activities at these water bodies would have the potential to cause impacts as described in Section 4A.3.3.1.

FISH-JUDY CREEKS FACILITY GROUP

Ten new pads and one new processing facility in the Fish Creek watershed (including Judy Creek and the Ublutuoch River) are hypothesized.

HP-1 and HPF-1 have been moved out of the area around the Fish and Judy creek drainages designated for no permanent oil and gas facilities by the BLM and MMS (1998a). Thus, the potential impacts to these sensitive habitats would be reduced relative to Alternative A FFD. HP-11 would be in the sensitive area near the Colville River, as designated by the BLM and MMS (1998a), and would require consultation. HP-16, HP-17, and HPF-1 would be in the sensitive area around the Fish and Judy creek drainages, as designated by the BLM and MMS (1998a), and would require consultation.

The road network of this hypothetical development is less extensive than that of Alternative A. If roads are not routed along high ground to the extent possible, relatively large areas of fish habitat could be affected during road construction. Roads from CD-7 to HP-18 and from CD-6 to HP-15, which would be perpendicular to the primary drainage flow which could dam overland drainage, are not included in this alternative; therefore, the potential landscape-scale disruption of drainage patterns has been largely eliminated in this FFD Alternative. Furthermore, the pipeline crossing the Fish and Judy creek drainages crosses much less (compared with Alternative A) of these sensitive portions of these drainages.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Three new pads and one new processing facility in the Kalikpik-Kogru river drainages are hypothesized.

As with the Fish-Judy Creeks Facility Group, the road network of this hypothetical development is extensive. Therefore, relatively large areas of fish habitat might be affected during road construction if roads are not routed along high ground to the extent possible. The road from HP-18 to HPF-2 is perpendicular to the primary drainage flow and thus may function as a dam on a landscape scale, disrupting natural hydrology and obstructing fish movement over a wide area. Bridges or culverts installed in low-lying areas may mitigate this effect. HP-22, near Harrison Bay, has been eliminated; therefore, there would be no direct impacts northeast of HP-21.

4B.3.2.3 Alternative B – Summary of Impacts (CPAI and FFD) on Fish

Within the Plan Area, the primary concerns are generally the same as those arising from Alternative A, namely, impacts to winter habitat, feeding areas, and spawning areas as well as access to those sites.

Water withdrawal for winter construction could create overcrowding and reduce the available pool of dissolved oxygen in a water body, with fish mortality a possible result. Permit limits on amounts of water withdrawn are set to avoid such effects. Because the pipeline over the Nigliq Channel would be suspended from supports on either bank (i.e., no in-stream structures), suspension of oxygen-demanding materials during construction of the Nigliq Channel bridge is not a concern in Alternative B.

Construction of pads, roads, and pipelines is likely to have no measurable adverse effect on arctic fish populations. Construction of ice roads or airstrips on fish overwintering areas could cause freezing to the bottom and block fish movement if state requirements to maintain fish passage are not met. The new road system could facilitate increased human access to fishing areas, despite these roads being closed to local residents in Alternative B, potentially increasing subsistence fishing pressures. Because the road system of Alternative B would be shorter than that of Alternative A, impacts would be on a smaller scale.

Gravel mining would most likely have direct impacts if situated within the floodplains of rivers. Sedimentation from erosion could affect fish and other aquatic organisms by interfering with respiration and vision and by smothering benthic habitat.

The long network of roads in the FFD scenario could result in alteration of regional surface hydrology, including interruption of fish movements, in the Kalikpik- Kogru river drainages and in the lower Fish Creek drainage.

If culverts are installed, any failures may impound water, thus creating a new pond or lake upstream of the culvert and diminishing flow downstream; in turn, this would interrupt fish movement. Stream morphology changes could occur downstream of culverts as a result of altered flow.

Release of contaminants over the project duration and the impacts of oil spills are important concerns to fish resources; these issues are addressed in Section 4.3.

The potential impacts described above, should they occur, are likely to be localized and temporary and thus would have no significant effects on fish populations within and adjacent to the Plan Area. Given the total amount of construction proposed, the collective effects of development and production would have some effect on fish and fish habitats in the region. Whether those effects are measurable and distinguishable from naturally occurring population perturbations is unknown. Minor shifts in habitat or population integrity, especially if they are of a temporary nature, could reasonably be absorbed by the ecosystem. Furthermore, careful planning, appropriate engineering specification and design, and rigorous safety measures should minimize impacts and ensure the reproductive sustainability of stocks overall. Localized impacts could pose a more serious threat to localized (e.g., within a single drainage) stocks if they were to occur in or near prime spawning, nursery, or overwintering sites. Continued monitoring of fisheries resources is vital for evaluating long-term stability of the region. Monitoring and mitigation plans should be finalized and ready to address any signs that development may be having a truly detrimental effect on local fish populations.

ESSENTIAL FISH HABITAT

The impacts on EFH for Alternative B are the same as for Alternative A with one major exception: project facilities would be moved outside the 3-mile sensitive area around Fish Creek, thereby reducing the potential for impacts to this salmon stream. The potential impacts from Alternative B to fish in general are described in Section 4B.3.2. As is the case with Alternative A, because the Plan Area represents marginal habitat for salmon populations, the probability of affecting EFH from a species and commercial perspective is minimal.

4B.3.2.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Fish

1. At project completion, gravel mines should be converted to fish habitat if practicable.

2. Ice roads and airstrips should avoid fish overwintering areas where possible, and in all cases maintain fish passage.

3. CPAI should continue fish monitoring studies in the Plan Area to ensure that the health of regional and locally important fish stocks is maintained. CPAI's mitigation plan should include remedial measures to be taken should monitoring detect adverse impacts due to the project.

4B.3.2.5 Alternative B – Effectiveness of Protective Measures for Fish

The effectiveness of the protective measures would be similar to Alternative A.

4B.3.3 Birds

See discussions of impacts by bird group presented in Section 4A.3.3 Birds for additional descriptions of impact mechanisms and for description of impact calculation assumptions and methods.

4B.3.3.1 Alternative B – CPAI Development Plan Impacts on Birds

Table 4B.3.3-1 presents the estimated number of nests displaced as a result of habitat loss, alteration and disturbance for the CPAI Development Plan Alternative B by bird species and species group. In CPAI Alternative B, facilities would be moved outside of the 3-mile sensitive area around Fish Creek, and power lines on poles would be replaced by power lines on cable trays on VSMs.

WATERFOWL AND LOONS

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Impacts to waterfowl and loons related to habitat loss and alteration would be the same as those described previously for Alternative A. The area covered by gravel or mined and lost as potential waterfowl and loon habitat would be reduced to 241 acres Alternative B from 306 acres in Alternative A. An estimated 8.2 waterfowl and 1.0 loon nests would be affected by habitat loss due to gravel placement and mining (Table 4B.3.3-1). Habitat loss and alteration would be similar to Alternative A in the Colville River Delta (Table 4B.3.3-2), and would be reduced by about 50 percent in the National Petroleum Reserve-Alaska area. Impacts to waterfowl and loon habitat from dust, snow drifting, and alterations in thermal and moisture regimes would be reduced affecting an estimated 17.6 fewer waterfowl nests and 2.5 fewer loon nests by the elimination of roadways in Alternative B (Table 4B.3.3-1 and Table 4A.3.3-2). However, impacts from ice roads would be increased slightly during the construction period (Table 4B.3.3-1).

Disturbance and Displacement

Fewer waterfowl and loons would be displaced by vehicle traffic by the reduction in the road system. However, the addition of two airstrips would cause additional disturbance to an estimated 32.8 additional waterfowl nests and 2.1 additional loon nests compared to Alternative A (Table 4B.3.3-1 and Table 4A.3.3-2).

OBSTRUCTIONS TO MOVEMENT

Potential obstruction of movement would be reduced in Alternative B compared to Alternative A by the removal of the road between CD-2 and CD-5 to CD-6. The general reduction in gravel fill would result in a reduction in potential obstruction of movements for brood-rearing waterfowl and loons (Table 4B.3.3-2).

MORTALITY

Mortality resulting from collisions with vehicles would be reduced in Alternative B from that in Alternative A with the reduction in the road system. The addition of two airstrips would increase mortality resulting from collisions with aircraft. Mortality resulting from collisions with power lines on poles would be reduced in Alternative B compared with Alternative A by placement of the power lines on pipeline VSMs between CD-6 and CD-7.

Any increase in predator populations attracted to the development areas would result in decreased reproductive success for waterfowl and loons. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as long-tailed ducks (Mallek et al. 2003) and red-throated loons (Larned et al. 2003); and to colonial nesting species which concentrate in specific locations providing an abundant and predictable protein source. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

TABLE 4B.3.3-1 CPAI ALTERNATIVE B – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Waterfowl											
Greater white-fronted goose	2.1	4.8	1.0	15.9	23.9	3.2	9.5	3.4	19.9	36.0	59.9
Snow goose	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Canada goose	0.0	0.1	0.0	0.1	0.2	0.8	2.4	0.8	6.0	10.0	10.2
Brant	0.2	0.4	0.1	2.0	2.7	0.4	1.1	0.4	3.0	4.9	7.6
Tundra swan	0.1	0.3	0.1	0.4	0.9	0.0	0.1	0.0	0.3	0.4	1.3
Mallard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern shoveler	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.3	0.4	0.5
Northern pintail	0.2	0.4	0.2	0.3	1.1	0.2	0.3	0.1	0.8	1.4	2.5
Green-winged teal	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.3	0.4	0.5
Greater scaup	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Lesser scaup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King eider	0.0	0.0	0.0	0.1	0.1	0.3	0.9	0.4	0.8	2.4	2.5
Long-tailed duck	0.2	0.6	0.1	2.0	2.9	0.3	0.7	0.2	1.4	2.6	5.5
Waterfowl Total[b]	**2.8**	**7.0**	**1.6**	**21.0**	**32.4**	**5.4**	**15.1**	**5.3**	**32.8**	**58.6**	**91.0**
Loons											
Red-throated loon	0.1	0.3	0.1	0.8	1.3	0.1	0.2	0.1	0.5	0.9	2.2
Pacific loon	0.2	0.5	0.2	1.3	2.2	0.5	1.3	0.5	1.5	3.7	5.9
Yellow-billed loon	0.1	0.1	0.0	0.4	0.6	0.1	0.1	0.1	0.1	0.4	1.0
Loon Total[b]	**0.3**	**0.9**	**0.3**	**2.5**	**4.0**	**0.7**	**1.6**	**0.7**	**2.1**	**5.1**	**9.1**
Ptarmigan											
Willow ptarmigan	0.3	0.6	0.2	0.4	1.5	0.3	0.9	0.2	2.4	3.8	5.3
Rock ptarmigan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ptarmigan Total[b]	**0.3**	**0.6**	**0.2**	**0.4**	**1.5**	**0.3**	**0.9**	**0.2**	**2.4**	**3.8**	**5.3**
Seabirds											
Parasitic jaeger	0.0	0.1	0.0	0.1	0.2	0.1	0.2	0.1	0.2	0.6	0.8
Long-tailed jaeger	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.1	0.3	0.6	0.7
Glaucous gull	0.1	0.2	0.0	0.6	0.9	0.3	1.0	0.4	1.7	3.4	4.3
Sabine's gull	0.0	0.1	0.0	0.6	0.7	0.2	0.2	0.1	0.0	0.5	1.2
Arctic tern	0.2	0.5	0.1	1.1	1.9	0.3	0.9	0.4	0.8	2.4	4.3

TABLE 4B.3.3-1 CPAI ALTERNATIVE B – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE (CONT'D)

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Seabird Total[b]	**0.3**	**1.0**	**0.2**	**2.4**	**3.9**	**0.9**	**2.6**	**1.1**	**3.0**	**7.6**	**11.5**
Shorebirds											
Black-bellied plover	0.5	1.6	0.5	0.0	2.6	0.7	2.3	1.2	0.0	4.2	6.8
American golden-plover	0.6	1.9	0.6	0.0	3.1	0.6	1.9	0.8	0.0	3.3	6.4
Bar-tailed godwit	0.1	0.4	0.1	0.0	0.6	0.2	0.8	0.3	0.0	1.3	1.9
Semipalmated sandpiper	5.3	18.1	5.9	0.0	29.3	4.0	14.0	6.7	0.0	24.5	53.8
Baird's sandpiper	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.2
Pectoral sandpiper	10.0	34.3	11.2	0.0	55.5	8.0	15.8	6.3	0.0	30.0	61.8
Dunlin	0.4	1.2	0.4	0.0	2.0	0.6	2.3	0.9	0.0	3.7	5.7
Stilt sandpiper	0.5	1.6	0.5	0.0	2.6	0.7	2.6	1.1	0.0	4.4	7.0
Buff-breasted sandpiper	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.5	0.0	1.4	1.4
Long-billed dowitcher	0.8	2.7	0.9	0.0	4.4	2.5	7.1	3.0	0.0	12.5	16.9
Red-necked phalarope	2y5	8.5	2.8	0.0	13.8	5.0	7.8	3.2	0.0	15.9	29.7
Red phalarope	1.7	5.8	1.9	0.0	9.4	1.6	4.2	1.7	0.0	7.4	16.8
Shorebird Total[b]	**22.2**	**76.0**	**24.8**	**0.0**	**123.0**	**24.1**	**59.7**	**25.5**	**0.0**	**108.8**	**231.8**
Passerines											
Yellow wagtail	0.1	0.4	0.1	0.0	0.6	0.0	0.3	0.2	0.0	0.5	1.1
Savannah sparrow	0.6	1.9	0.6	0.0	3.1	1.2	2.4	1.1	0.0	4.6	7.7
Lapland longspur	10.1	34.6	11.3	0.0	56.0	13.6	34.9	14.7	0.0	63.0	119.0
Common redpoll	0.1	0.4	0.1	0.0	0.6	0.4	1.9	0.8	0.0	3.0	3.6
Passerine Total[b]	**10.9**	**37.3**	**12.2**	**0.0**	**60.4**	**15.2**	**39.5**	**16.8**	**0.0**	**71.2**	**131.6**

Notes:

[a] Section 4A.3.3 Birds for analysis method

[b] Totals rounded to include birds with <0.1 nests/km^2

TABLE 4B.3.3-2 CPAI ALTERNATIVE B – SUMMARY OF AFFECTED HABITAT TYPES USED BY WATERFOWL, LOONS AND SEABIRDS

Habitat Types	Colville Delta						NPR-A				
	Acres in Colville River Delta[b]	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (16)			Acres in the NPR-A	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (20)	
				Nesting	Brood-rearing (13)	Staging (3)				Nesting	Brood-rearing (15)
Open Nearshore Water	1,162					1	0				
Brackish Water	1,807			2		2	2				
Tapped Lake with Low-water Connection	5,397					1	412				
Tapped Lake with High-water Connection	5,146	1.0	<0.1%	5			7				
Salt Marsh*	4,473	0.5	<0.1%	2	1	1	36				
Tidal Flat*	18,187					1	0				
Salt-killed Tundra*	6,362			5	1	1	0				
Deep Open Water without Islands*	5,650	1.3	<0.1%	4	5		12,386	<0.1	<0.1%	1	3
Deep Open Water with Islands or Polygonized Margins*	2,160	8.0	0.4%	12	8	1	9,988	<0.1	<0.1%	3	6
Shallow Open Water without Islands	547						1,744	1.8	<0.1%	5	3
Shallow Open Water with Island or Polygonized Margins	155	<0.1	<0.1%	4	4		2,877	1.6	<0.1%	11	7
River or Stream	20,306	2.5	<0.1%			1	1,456				
Aquatic Sedge Marsh	32						3,037	3.2	0.1%	10	2
Aquatic Sedge with Deep Polygons	3,275	15.3	0.5%	12	3		66				
Aquatic Grass Marsh*	369	1.6	0.4%	2			501			2	
Young Basin Wetland Complex*	0						624	19.1	3.1%	9	3
Old Basin Wetland Complex*	2						15,673	30.2	0.2%	12	4
Riverine Complex*	0						698			3	1
Dune Complex	0						1,889				
Nonpatterned Wet Meadow	11,162	36.0	0.3%	7	2		5,697	29.0	0.5%	4	
Patterned Wet Meadow	27,969	125.5	0.4%	8	4		19,861	23.6	0.1%	7	1
Moist Sedge-Shrub Meadow	2,927	69.8	2.4%	2			42,071	168.9	0.4%	8	1
Moist Tussock Tundra	525						49,647	267.7	0.5%	3	1
Riverine Low and Tall Shrub*	1,270						1,803	<0.1	<0.1%		1
Upland Low and Tall Shrub	419						735				
Upland and Riverine Dwarf Shrub*	0						2,240	<0.1	<0.1%		
Riverine or Upland Shrub*	6,305	24.4	0.4%	2			0				

TABLE 4B.3.3-2 CPAI ALTERNATIVE B – SUMMARY OF AFFECTED HABITAT TYPES USED BY WATERFOWL, LOONS AND SEABIRDS

Habitat Types	Colville Delta						NPR-A				
				Species[a] (16)						Species[a] (20)	
	Acres in Colville River Delta[b]	Loss or Alteration[c] (Acres and % of Available Habitat)		Nesting (16)	Brood-rearing (13)	Staging (3)	Acres in the NPR-A	Loss or Alteration[c] (Acres and % of Available Habitat)		Nesting (20)	Brood-rearing 15)
Barrens (riverine, eolian, or lacustrine)	20,993	9.9	<0.1%	2			1,552				
Artificial (water, fill, peat road)	38						150				
Total Area	**146,638**	**295.8**	**0.2%**				**175,152**	**545.3**	**0.3%**		

Notes: (replaced with revised table 4/30/04 LEN)

* Key wetland

[a] Numbers of species using habitats by life history stage (Johnson et al. 2004). Species included are: greater white-fronted goose, snow goose, Canda goose, brant, tundra swan, northern pintail, green-winged teal, greater scaup, spectacled eider, king eider, long-tailed duck, red-breasted merganser, red-throated loon, Pacific loon, yellow-billed loon, parasitic jaeger, long-tailed jaeger, glaucous gull, Sabine's gull, Arctic tern,

[b] Habitat type mapped for the Colville River Delta (Jorgenson et al. 1997) within the Plan Area boundaries

[c] Total includes gravel for pads and airstrips and area indirectly affected by dust, snowdrifts, and alteration in thermal or moisture regimes (Table 4B.3.1-1)

[d] Habitat type mapped for the National Petroleum Reserve-Alaska area (Jorgenson et al. 2003c) within the Plan Area boundaries

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. These impacts would be reduced in Alternative B compared with Alternative A because of the reduced amount of gravel fill (Table 4B.3.3-2).

Disturbance and Displacement

Under Alternative B, loons and waterfowl would be subjected to the same types of disturbances discussed previously for Alternative A, including disturbances related to vehicular and air traffic. Disturbances to waterfowl and loons by vehicle traffic would be reduced in Alternative B from Alternative A by the reduction in the road system. This reduction is reflected in the estimated number of nests displaced due to habitat alteration within 165 feet of roads, pads and airstrips (Table 4B.3.3-1 and Table 4A.3.3-2). Disturbance related to air traffic would be increased for waterfowl and loons by the addition of airstrips at CD-5 and CD-6 (Table 4B.3.3-1).

Obstructions to Movement

Potential obstructions to waterfowl and loon movements related to the presence of gravel roads would be reduced in Alternative B compared to Alternative A by the reduction in the road system and the general reduction in gravel fill between alternatives (Table 4B.3.3-2).

Mortality

Potential mortality from collisions with vehicles would be reduced in Alternative B from Alternative A by the reduction in the road system. Potential mortality from collisions with aircraft would be increased in Alternative

B compared to Alternative A by the addition of airstrips at CD-5 and CD-6. Any increase in predator populations would result in decreased reproductive success for waterfowl and loons. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as long-tailed ducks (Mallek et al. 2003) and red-throated loons (Larned et al. 2003); and to colonial nesting species which concentrate in specific locations providing an abundant and predictable protein source. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

PTARMIGAN

CONSTRUCTION PERIOD

Habitat Loss, Alteration, and Enhancement

The area covered by gravel and lost as potential ptarmigan habitat would be reduced in Alternative B from Alternative A (Table 4B.3.3-1). Impacts to ptarmigan habitat from dust, snow drifting and alterations in thermal or moisture regimes would be reduced by the elimination of roadways in Alternative B compared to Alternative A. However, impacts from ice roads would be increased slightly during the construction period (Table 4B.3.3-1). An estimated 0.9 fewer ptarmigan nests would be affected by habitat loss and alteration under Alternative B compared to Alternative A (Table 4B.3.3-1 and Table 4A.3.3-2).

Disturbance and Displacement

Some ptarmigan might remain on the Arctic Coastal Plain during winter, and a few birds could be disturbed or displaced during construction. In Alternative B, any potential for disturbance would be reduced compared to Alternative A because of the reduction in gravel placement for the road system. Disturbance from aircraft traffic would be increased in Alternative B compared to Alternative A by the addition of airstrips at CD-5 and CD-6. Potential displacement due to air traffic would affect an estimated 2.4 ptarmigan nests(Table 4B.3.3-1).

Obstructions to Movement

Movements of ptarmigan are unlikely to be affected by gravel placement for roads, well pads, and airstrips because ptarmigan can fly over or around such structures. Ptarmigan may use some structures, such as pipelines, for perches.

Mortality

Ptarmigan could suffer mortality from collisions with vehicular traffic, machinery, buildings, bridges, and pipelines during the construction phase of the development. Ptarmigan were among the species of birds most often struck by traffic in association with the TAPS project, although the number of birds lost was likely low compared to area populations (TAPS Owners 2001). Under Alternative B the potential for ptarmigan mortality from collisions with vehicular traffic would be reduced compared to Alternative A because of the reduction in the road system for this alternative. Ptarmigan may collide with aircraft, and mortality would be increased by the addition of airstrips at CD-5 and CD-6.

Any increase in predator populations would result in increased adult mortality and decreased reproductive success for ptarmigan. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. Mortality caused by avian predators may be reduced in Alternative B compared to Alternative A by reduction in available perching habitat for avian predators with placement of power lines on VSMs between CD-6 and CD-7. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which aggregate in predictable locations year to year, and with low total population sizes.

OPERATION PERIOD

Habitat Loss, Alteration, and Enhancement

Some habitat loss and alteration would continue from dust deposition, snowdrifts, thermokarst, and ponding during project operations. Construction of annual ice roads during drilling would continue to alter ptarmigan winter and nesting habitat during project operation.

Disturbance and Displacement

Disturbance and displacement of ptarmigan in the CD-3 and CD-4 areas under Alternative B would be the same as that describe for Alternative A. At the National Petroleum Reserve-Alaska sites, overall disturbance due to vehicle traffic would be reduced under Alternative B compared to Alternative A because of a reduction in the road system. Disturbance would increase in the immediate area of the CD-5 and CD- 6 airstrips (Table 4B.3.3-1). Potential disturbance at the CD-7 site would be the same as that described under Alternative A.

Obstructions to Movement

Potential obstruction to movements of ptarmigan under Alternative B would be reduced compared to Alternative A because of the reduced road system under Alternative B. Obstruction to movements would be expected to be minimal because of the ability of ptarmigan to easily move over or around infrastructure.

Mortality

Under Alternative B the potential for collisions of ptarmigan with vehicular traffic would be reduced compared to Alternative A during the summer because of a reduction in the road system. As under Alternative A, increased levels of depredation from predators attracted to developed areas would increase adult, egg, and chick mortality of ptarmigan. Mortality caused by avian predators may be reduced in Alternative B compared to Alternative A by reduction in available perching habitat for avian predators with placement of power lines on VSMs between CD-6 and CD-7.

RAPTORS AND OWLS

Habitat loss and disturbance resulting from the proposed development under Alternative B are unlikely to affect raptors and owls because of the low numbers of those birds reported in the Plan Area. Raptors may use structures as perches. Perches would be reduced in Alternative B compared to Alternative A because power lines would be placed on VSMs instead of poles between CD-6 and CD-7. Gravel roads, buildings, pipelines, and bridges are unlikely to obstruct movements of raptors and owls. The small number of raptors and owls in the Plan Area could suffer mortality from collisions with vehicles, aircraft, buildings, bridges, or pipelines.

SHOREBIRDS

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Habitat loss and alteration resulting from gravel placement and mining would be reduced in Alternative B compared to Alternative A (Table 4B.3.3-2 and Table 4A.3.3-3). The proportion of available Moist Tussock Tundra and Patterned Wet Meadow habitats filled by gravel would be reduced in Alternative B compared to Alternative A, although both alternatives would affect a very small proportion of the available habitat (Table 4B.3.3-2 and Table 4A.3.3-3). Loss of tundra habitat due to gravel mining would be reduced under Alternative B compared to Alternative A because of the reduction in total gravel fill. Habitat alteration resulting from ice roads would be increased slightly in Alternative B compared to Alternative A (Table 4B.3.3-1). An estimated

231.8 shorebird nests would be affected by habitat loss and alteration under Alternative B, which is reduced from an estimated 346.9 nests affected by Alternative A.

Disturbance and Displacement

Impacts to shorebirds from human activities during summer construction activities at production pads would be similar for Alternative B to those described for Alternative A. Impacts at CD-3, CD-4, and CD-7 would be the same. Disturbance from vehicle traffic from CD-2 to CD-5, and CD-5 to CD-6 would be eliminated. Noise-related impacts associated with aircraft would be increased at CD-5 and CD-6, although no disturbance pattern was found for nesting shorebirds at APF-1 (Johnson et al. 2003a). Disturbance to staging shorebirds in the lower Colville River Delta due to air traffic at the CD-3 site would be the same as Alternative A, affecting an estimated 313 shorebirds within 500 meters of the airstrip.

Obstructions to Movements

Potential obstructions to movements of shorebird broods by roadways would be reduced in Alternative B compared to Alternative A because of the removal of the roads connecting CD-2 to CD-6.

Mortality

Potential mortality from collisions with vehicles would be decreased in Alternative B compared to Alternative A by the reduction in the road system. Any increase in predator populations attracted to development areas would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers and dunlin. Mortality of adults, nests, and juveniles from depredation may be decreased in Alternative B compared to Alternative A because power lines would be placed on VSMs instead of on poles.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Habitat loss and alteration would continue during project operations. Habitat alteration from dust, snowdrifts, and alteration of thermal and moisture regimes would be reduced in Alternative B compared to Alternative A because of the reduction in the road system, while habitat alteration resulting from ice road construction during drilling would be increased slightly in Alternative B compared to Alternative A (Table 4B3.3-1).

Disturbance and Displacement

Disturbance resulting from vehicle traffic would be reduced in Alternative B compared to Alternative A because of the reduction in the road system. Disturbance by aircraft would be increased by the addition of airstrips at CD-5 and CD-6, although disturbance was not found to affect nesting density of shorebirds at Alpine (Johnson et al. 2003a). Disturbance to staging shorebirds in the lower Colville River Delta would be the same as Alternative A.

Obstructions to Movements

Obstructions to movements of brood-rearing shorebirds would be reduced in Alternative B compared to Alternative A by the reduction in the road system.

Mortality

Potential mortality from collisions with vehicles would be reduced in Alternative B compared to Alternative A because of the reduction in the road system. Potential mortality from collisions with aircraft would not be expected. Any increase in predator populations attracted to development areas would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers and dunlin. Potential mortality from depredation by avian predators attracted to the development may be reduced in Alternative B compared to Alternative A by placement of power lines on VSMs instead of poles, eliminating power lines as potential perching habitat for avian predators.

SEABIRDS (GULLS, JAEGERS, AND TERNS)

CONSTRUCTION PERIOD

Habitat Loss, Alteration, and Enhancement

Habitat loss and alteration would be reduced in Alternative B in the National Petroleum Reserve-Alaska area due to the reduction in total gravel fill by the elimination of roadways between CD-2, CD-5 and CD-6. An estimated 4.3 fewer seabird nests would be affected by habitat loss and alteration in Alternative B compared to Alternative A (Table 4B.3.3-1 and Table 4A.3.3-2). Impacts to habitats used by seabirds would be similar in the Colville River Delta (Table 4B.3.3-2 and Table 4A.3.3-3). Impacts to Young and Old Basin Wetland Complexes are similar between Alternative A and Alternative B, although impact to other wetlands used by seabirds are reduced in Alternative B (Table 4B.3.3-2 and Table 4A.3.3-3). Habitat impacts from ice roads would be increased slightly during the construction period (Table 4B.3.3-1 and Table 4A.3.3-2).

Disturbance and Displacement

Disturbance due to vehicle traffic would be reduced by elimination of the road connecting CD-2 and CD-6 in Alternative B compared to Alternative A. Disturbance from air traffic would be increased in Alternative B by the addition of airstrips at CD-5 and CD-6 resulting in an estimated additional 3.0 seabird nests affected by disturbance (Table 4B.3.3-1 and Table 4A.3.3-2).

Obstructions to Movement

Potential obstruction of movements of seabird broods would be reduced by the elimination of the roads between CD-2, CD-5, and CD-6.

Mortality

Potential seabird mortality resulting from collisions with vehicles would be reduced in Alternative B compared to Alternative A by the reduction in the road system. Potential mortality from collisions with aircraft compared to Alternative A would increase with the addition of airstrips at CD-5 and CD-6 in Alternative B. Gulls in particular are vulnerable to mortality caused by collisions with both vehicles and aircraft. Mortality due to collisions with power lines would be reduced in Alternative B with the elimination of power lines on poles from CD-6 to CD-7 in Alternative B. Any increase in predator populations attracted to the development could result in decreased reproductive success for seabirds. The magnitude and extent of this decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003).

OPERATION PERIOD

Habitat Loss, Alteration, and Enhancement

Habitat loss and alteration would continue during project operation as a result of gravel spray, dust fallout, and ice road construction in support of drilling operations. Habitat alteration caused by dust fallout would be reduced in Alternative B compared to Alternative A by the reduction in the road system.

Disturbance and Displacement

Disturbance caused by vehicle traffic along roadways would be reduced in Alternative B compared to Alternative A by the reduction in the road system. Disturbance from air traffic would be increased in Alternative B compared to Alternative A by the addition of airstrips at CD-5 and CD-6 (Table 4B.3.3-1 and Table 4A.3.3-2). In addition, potential hazing of seabirds from the area surrounding the additional airstrips would increase disturbance to seabirds.

Obstructions to Movement

Potential obstructions to movements of seabird broods would be reduced in Alternative B compared to Alternative A because of the reduction in the road system.

Mortality

Under Alternative B, the potential for seabird mortality resulting from collisions with vehicular traffic or bridges would be reduced compared to Alternative A because of the reduction in the road system. Potential seabird mortality caused by collisions with aircraft would be increased by the addition of airstrips at CD-5 and CD-6. Mortality due to collisions with power lines would be reduced in Alternative B with the elimination of power lines on poles from CD-6 to CD-7 in Alternative B. Any increase in predator populations attracted to the development could result in decreased reproductive success for seabirds. The magnitude and extent of this decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003).

PASSERINES

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Gravel fill at CD-3 and CD-4 would be the same for Alternative B as for Alternative A. Habitat loss and alteration at these locations would be the same for passerines in both of these alternatives. Habitat loss and alteration would be reduced in the National Petroleum Reserve-Alaska portion of the Plan Area due to the elimination of the road system from CD-2, CD-5 and CD-6 in Alternative B compared to Alternative A (Table 4B.3.3-1 and Table 4A.3.3-2). Habitat loss from gravel mining would also be reduced in Alternative B compared to Alternative A by the reduction in the total amount of gravel used for construction. An estimated 74.4 fewer passerine nests would be affected by habitat loss and alteration for Alternative B compared to Alternative A. Elimination of the bridges across the Nigliq Channel and the Ublutuoch River would reduce the impacts to shrub habitats used by nesting passerines (Table 4B.3.3-2 and Table 4A.3.3-3), although ice bridges would alter these habitats. Habitat enhancement for ravens and snow buntings would be similar for Alternatives B and A because buildings would be the same for these alternatives. Perching habitat would be reduced for ravens in Alternative B compared to Alternative A by placement of power lines on VSMs instead of poles.

Disturbance and Displacement

Disturbance from vehicle traffic would be reduced in Alternative B compared to Alternative A by the reduction in the road system. Disturbance from air traffic would be increased by the airstrips at CD-5 and CD-6, although the Alpine Development Project airstrip was not found to cause disturbance-related reduction in nesting of passerines (Johnson et al. 2003a).

Obstructions to Movements

No obstruction to movements of passerines is expected from construction of the project.

Mortality

Potential mortality caused by collisions with vehicles is reduced in Alternative B compared to Alternative A by the reduction in the road system. No mortality from collisions with aircraft is expected for passerines. Construction of oil development facilities may result in an increase in predator species such as foxes, bears, glaucous gulls, and common ravens. Any increase in predator populations could result in increased adult mortality and decreased reproductive success for passerines. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with declining populations.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Impacts to passerines from habitat loss and alteration would continue during project operation. Ice roads for annual access to CD-5 across riparian habitats and the Nigliq Channel might melt out later during spring and cause additional damage to willow communities used by nesting yellow wagtails, American tree sparrows, common redpolls, and hoary redpolls.

Disturbance and Displacement

Impacts from disturbance by vehicle traffic would be reduced in Alternative B compared to Alternative A because of the reduced road system. Potential disturbance impacts to passerines from air traffic would increase in Alternative B compared to Alternative A because of the airstrips at CD-5 and CD-6, although no difference in nesting densities of passerines was found near the Alpine Development Project airstrip (Johnson et al. 2003a).

Obstructions to Movements

Operational activities are not anticipated to obstruct movements of passerines.

Mortality

Potential mortality resulting from collisions with vehicles is lower in Alternative B compared to Alternative A because of the reduced road system. Mortality from collisions with aircraft is not expected for passerines and would not be increased by the addition of airstrips at CD-5 and CD-6. Potentially increased depredation by avian predators would be decreased in Alternative B compared to Alternative A by placement of power lines on VSMs instead of poles. Any increase in predator populations attracted to development areas could result in increased adult mortality and decreased reproductive success for passerines. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with declining populations.

4B.3.3.2 Alternative B – Full-Field Development Scenario Impacts on Birds

The mechanisms associated with habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups would be the same as those described under Alternative A (Section 4A.3.3). Table 4B.3.3-3 summarizes impacts for Alternative B FFD based on assumptions and calculation methods presented in Section 4A.3.3 for estimated numbers of bird nests affected in the Colville River Delta and the National Petroleum Reserve-Alaska. In FFD Alternative B, all facilities would be moved outside of the 3-mile sensitive area around Fish Creek. Roads would link many of the production pads in the Fish-Judy Creeks and Kalikpik-Kogru Rivers facility groups, although airstrips would be situated at several sites. In the Colville River Delta Facility Group, the proposed facilities for FFD would be the same as those discussed for Alternative A FFD.

COLVILLE RIVER DELTA FACILITY GROUP

Table 4B3.3-3 presents a summary of the estimated numbers of bird nests affected by habitat loss, alteration and disturbance due to the hypothetical FFD in the Colville River Delta.

TABLE 4B.3.3-3 ALTERNATIVE B - FFD ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Bird Group	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total[a]
Colville River Delta Facility Group					
Waterfowl	5	14	3	32	54
Loons	1	2	0	5	8
Ptarmigan	1	2	0	4	7
Raptors and Owls	0	0	0	0	0
Seabirds	1	2	0	4	7
Shorebirds	72	219	44	0	335
Passerines	35	107	22	0	164
Total Nests	**115**	**346**	**69**	**45**	**575**
Fish-Judy Creeks Facility Group					
Waterfowl	31	89	5	45	170
Loons	4	11	0	6	21
Ptarmigan	1	4	0	2	7
Raptors and Owls	0	0	0	0	0
Seabirds	6	19	1	10	36
Shorebirds	149	431	24	0	604
Passerines	98	284	16	0	398
Total Nests	**289**	**838**	**46**	**63**	**1,236**
Kalikpik-Kogru Rivers Facility Group					
Waterfowl	10	48	8	15	81
Loons	1	6	1	2	10
Ptarmigan	1	2	0	1	4
Raptors and Owls	0	0	0	0	0
Seabirds	2	10	2	3	17
Shorebirds	50	230	39	0	319
Passerines	33	152	25	0	210
Total Nests	**97**	**448**	**75**	**21**	**641**

Notes:

[a] Section 4A.3.3 for assumptions and calculation methods

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

Total habitat loss and alteration resulting from gravel placement would be similar in Alternative B FFD to that in Alternative A FFD, resulting in a similar number of estimated bird nests affected (Table 4B.3.3-3 and Table 4A.3.3-4). Ice roads and dust fallout would be increased slightly in Alternative B compared to Alternative A.

DISTURBANCE AND DISPLACEMENT

Potential disturbance and displacement by vehicle traffic at CD-4, HP-4, and HP-5 would be reduced in Alternative B FFD compared to Alternative A FFD by elimination of the road between CD-2 and CD-5 allowing access to the Delta from Nuiqsut. This would reduce potential traffic from the local community to these facilities. Disturbance due to air traffic would be similar for Alternative B and Alternative A FFD (Table 4B.3.3-3 and Table 4A.3.3-4).

OBSTRUCTIONS TO MOVEMENTS

Obstructions to movements of birds would be decreased in Alternative B FFD compared to Alternative A FFD by the elimination of the road connecting CD-2 to CD-5. All other FFD components of these two alternatives in the Colville River Delta are similar.

MORTALITY

The reduced road system in Alternative B FFD compared with Alternative A would reduce mortality from collisions with vehicles and potential collisions with a bridge over the Nigliq Channel. Mortality resulting from collisions with aircraft would be the same in Alternative B and Alternative A. Potential mortality from hunting would be lower in Alternative B FFD than in Alternative A FFD if increased access to Nuiqsut by the road between CD-2 and CD-5 contributes to increased harvest.

Any increase in predator populations attracted to development areas could result in increased adult mortality and decreased reproductive success for birds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with declining populations, with low total population sizes, and which aggregate in predictable locations year to year. Within the Plan Area species which may be declining include long-tailed ducks (Mallek et al. 2003), red-throated loons (Larned et al. 2003); buff-breasted sandpipers (Lanctot and Laredo 1994), dunlin, jaegers and arctic tern (Mallek et al. 2003); with low total population sizes include red-throated loons, yellow-billed loons, buff-breasted sandpipers, and dunlin; and colonial nesting species include brant and snow geese.

FISH-JUDY CREEKS FACILITY GROUP

A summary of the estimated number of bird nests affected by the hypothetical FFD in the Fish-Judy Creek Facility Group area is presented in Table 4B.3.3-3.

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

Under Alternative B for FFD in the Fish-Judy Creeks Facility Group, the overall amount of habitat loss would be reduced compared to Alternative A because of the reduced road system and the elimination of one production pad. An estimated 409 bird nests (primarily shorebirds and passerines) would be unaffected by habitat loss and alteration in Alternative B compared to Alternative A FFD (Table 4B.3.3-3 and Table 4A.3.3-4). Habitat impacts would be moved outside of the 3-mile Fish Creek buffer, reducing impacts to Open and Closed Low and Tall Willow Shrub habitats by 58 percent from Alternative A FFD (Tables 4B.3.1-3, 4B.3.1-4, 4A.3.1-3, and 4A.3.1-4).

OBSTRUCTIONS TO MOVEMENTS

The reduced road system in Alternative B FFD compared with Alternative A FFD would result in less obstruction to movements for brood-rearing birds.

DISTURBANCE AND DISPLACEMENT

The reduction in the road system and reduced access for local traffic would result in fewer disturbances by vehicle traffic in Alternative B FFD than in Alternative A FFD. Disturbance from air traffic would be increased by the addition of airstrips at CD-5, CD-6, and CD-24, increasing disturbance to an additional 43 waterfowl, loon, ptarmigan and seabird nests (Table 4B.3.3-3, Table 4A.3.3-4).

MORTALITY

The reduction in the road system and removal of access for local traffic would result in less mortality from collisions with vehicles in Alternative B FFD than in Alternative A FFD. Mortality from collisions with aircraft would be increased by the addition of airstrips at CD-5, CD-6, and HP-17. Local access to Nuiqsut would be eliminated for Alternative B FFD to pad locations adjacent to the Colville River and Harrison Bay. Subsistence harvest of waterfowl may be increased by road access to HP-8, HP-9, CD-5, HP-3 and HP-1 for Alternative B FFD due to increased road access. Alternatively, developments in these areas may reduce hunting if subsistence users avoid developed areas. The road route between HP-6, HP-3, and HP-1 would cover more areas often used by molting waterfowl and areas of high nesting density for king eiders compared to the road route for Alternative A FFD.

Any increase in predator populations attracted to development areas could result in increased adult mortality and decreased reproductive success for birds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with declining populations, with low total population sizes, and which aggregate in predictable locations year to year. Within the Plan Area species which may be declining include long-tailed ducks (Mallek et al. 2003), red-throated loons (Larned et al. 2003); buff-breasted sandpipers (Lanctot and Laredo 1994), dunlin, jaegers and arctic tern (Mallek et al. 2003); with low total population sizes include red-throated loons, yellow-billed loons, buff-breasted sandpipers, and dunlin; and colonial nesting species include brant and snow geese.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

A summary of the estimated number of bird nests affected by the hypothetical FFD in the Kalikpik-Kogru Rivers Facility Group is presented in Table 4B.3.3-3.

HABITAT LOSS AND ALTERATION

Habitat loss and alteration are reduced in Alternative B FFD compared to Alternative A FFD by the elimination of the production pad and airstrip at HP-22. The addition of an airstrip at the HPF-2 site would increase habitat loss in the immediate area of the facility. An estimated 56 fewer birds nests would be affected by habitat loss and alteration in Alternative B FFD compared to Alternative A (Table 4B.3.3-3 and Table 4A.3.3-4)

DISTURBANCE AND DISPLACEMENT

Disturbance resulting from vehicle traffic in Alternative B FFD would be the same as Alternative A FFD. Disturbance from air traffic would be reduced in Alternative B FFD compared to Alternative A FFD with the elimination of the HP-22 pad and airstrip. An estimated 20 fewer waterfowl, loon, ptarmigan and seabird nests would be disturbed by air traffic in Alternative B compared to Alternative A (Table 4B.3.3-3 and Table 4A.3.3-4)

OBSTRUCTION TO MOVEMENT

Under Alternative B FFD, any potential obstruction to brood movements would be reduced compared to Alternative A FFD by the elimination of the HP-22 pad and airstrip.

MORTALITY

Mortality resulting from collisions with vehicles would be similar in Alternative B FFD as in Alternative A FFD although reduction in access to local traffic in Alternative B may decrease traffic levels. Mortality from collisions with aircraft would be reduced in Alternative B FFD compared to Alternative A FFD with the elimination of the airstrip at HP-22. The potential for subsistence hunting to affect birds would be reduced compared to Alternative A FFD by the elimination of access roads to the Kalikpik-Kogru Rivers Facility Group if hunters used the road system for access.

Any increase in predator populations attracted to development areas could result in increased adult mortality and decreased reproductive success for birds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with declining populations, with low total population sizes, and which aggregate in predictable locations year to year. Within the Plan Area species which may be declining include long-tailed ducks (Mallek et al. 2003), red-throated loons (Larned et al. 2003); buff-breasted sandpipers (Lanctot and Laredo 1994), dunlin, jaegers and arctic tern (Mallek et al. 2003); with low total population sizes include red-throated loons, yellow-billed loons, buff-breasted sandpipers, and dunlin; and colonial nesting species include brant and snow geese.

4B.3.3.3 Alternative B – Summary of Impacts for Alternative B (CPAI and FFD) on Birds

Impacts to birds associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests affected by habitat loss, alteration or disturbance for each alternative, based on site specific nesting densities for bird species and species groups to compare alternative development scenarios. Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative B would reduce nesting by 1 percent or less for Plan Area waterfowl, loon and seabird populations and less than 1 percent for Plan Area shorebird and passerine populations. FFD Alternative B would reduce nesting by 3 to 6 percent for Plan Area waterfowl, loon and seabird populations and 1 percent for Plan Area shorebird and passerine populations. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snow drifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The results of effects of these activities on estimated bird production due to loss, alteration or disturbance of nesting habitat for CPAI Development Plan and FFD Alternative B are presented in Table 4B.3.3-4.

TABLE 4B.3.3-4 CPAI AND FFD ALTERNATIVE B (CPAI AND FFD) – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

CPAI Alternative B Totals[a]					
Bird Group	**Habitat Loss**	**Habitat Alteration**	**Ice Road Habitat Loss**	**Air Traffic Disturbance**	**Total**
Waterfowl	8	22	7	54	91
Loons	1	2	1	5	9
Ptarmigan	1	2	0	2	5
Seabirds	1	4	1	5	11
Shorebirds	46	136	50	0	232
Passerines	26	77	29	0	132
Total Nests	**83**	**243**	**88**	**66**	**480**

TABLE 4B.3.3-4 CPAI AND FFD ALTERNATIVE B – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE (CONT'D)

CPAI Alternative B Totals[a]					
Bird Group	**Habitat Loss**	**Habitat Alteration**	**Ice Road Habitat Loss**	**Air Traffic Disturbance**	**Total**
FFD Alternative B Totals[a]					
Waterfowl	46	151	16	92	305
Loons	6	19	1	13	39
Ptarmigan	3	8	0	7	18
Seabirds	9	31	3	17	60
Shorebirds	271	880	107	0	1,258
Passerines	166	543	63	0	772
Total Nests	**501**	**1,632**	**190**	**129**	**2,452**

Notes:
[a] Section 4A.3.3 Birds for assumptions and calculation methods. Totals from Tables 4B.3.3-1 and 4B.3.3-3.

4B.3.3.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Birds

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.3.3).

4B.3.3.5 Alternative B – Effectiveness of Protective Measures for Birds

The effectiveness of the protective measures would be similar to Alternative A.

4B.3.4 Mammals

4B.3.4.1 Terrestrial Mammals

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON TERRESTRIAL MAMMALS

Alternative B would include 10 miles of road and 36 miles of pipeline (Figure 2.4.2.1-1). Alternative B would have 15.8 fewer miles of road than Alternative A (Figure 2.3.3.1-1. The primary pipeline route is similar to that in Alternative A and follows a southwest-northeast-oriented corridor from CD-2 in the Colville River Delta to the proposed CD-5, CD-6, and CD-7 production pads in the vicinity of Fish and Judy creeks. Alternative B differs from Alternative A in that the CD-6 site and the pipeline to it are moved to the southeast, out of the 3-mile setback around Fish Creek. Also, no road accompanies the pipeline from CD-2 to CD-6, and Alternative B has airstrips at CD-5 and CD-6. This configuration results in 16 fewer miles of road/pipeline combination in Alternative B than in Alternative A. As in Alternative A, no road accompanies the pipeline from CD-1 to CD-3. Important characteristics of Alternative B with regard to impacts on terrestrial mammals include the limited amount of road connecting most production pads, pipelines elevated to 5 feet, use of the roads by industry only, and airstrips at CD-3, CD-5, and CD-6.

CONSTRUCTION PERIOD

Direct Habitat Loss, Alteration, or Enhancement

During the winter construction period, habitat would be lost or altered by placement of gravel fill and ice roads. Alternative B would require a total of approximately 204 acres of gravel fill for roads, pads, and airstrips, and approximately 37 acres of vegetation cover lost due to gravel mining. This is 65 fewer acres of gravel fill than Alternative A. Sixteen miles of ice road (approximately 35 feet wide) would be necessary for the winter construction of the pipeline from CD-1 to CD-6. An ice road would be constructed to transport gravel from the Clover near the Ublutuoch River. Under Alternative B there would be slightly less direct loss of riparian habitat near the Nigliq Channel and the Ublutuoch River, which is generally important to terrestrial mammals on the North Slope. One existing arctic fox den in the Fish-Judy Creeks Facility Group could be affected by the construction of CD-5 and its associated airstrip (Burgess et al. 2002). Small mammals would lose less habitat to gravel fill than under Alternative A. See the Operation Period section under Alternative B, following, for quantification of habitat types lost or altered under gravel fill.

Obstruction of Movements

Winter movements of caribou could still be obstructed at construction sites as in Alternative A, but the effect might be less between CD-2 and CD-6 with construction of a pipeline but not a gravel road. Considering the tendency for caribou in winter to move less, to readily cross linear structures, and to occur at relatively low densities in the Plan Area, the obstruction to movements of caribou from winter construction of Alternative A and Alternative B would be similarly small in magnitude. Summer construction activity can also obstruct movements of caribou to some extent as described for Alternative A. The siting of CD-6 outside of the Fish Creek riparian zone under Alternative B could result in less obstruction of movements of moose or muskoxen there. Effects on other terrestrial mammals during construction would be similar to those for Alternative A.

Disturbance and Displacement

Disturbance of terrestrial mammals during the winter and summer construction activity would be mainly from noise and human activity associated with building the roads, pads, and airstrips. All of the production sites, except CD-6, in Alternative B are in the same locations as in Alternative A. In Alternative B, the CD-6 site and the pipeline to it would be outside of the Fish Creek riparian area. There would also be no gravel road between CD-2 and CD-6 in Alternative B. This would result in less disturbance in the Fish Creek riparian area and in the vicinity of the Ublutuoch River and Nigliq Channel during the construction phase of Alternative B. However, there would be additional construction activity and potential disturbance at the airstrips at CD-5 and CD-6 under Alternative B. The other components of Alternative B are the same as Alternative A, so the amount of disturbance during the construction phase would be comparable in these areas. As discussed under Alternative A, disturbance during construction could displace wintering caribou, muskoxen, and denning bears.

Mortality

Mortalities of terrestrial mammals associated with construction should be few and similar to those described in Alternative A.

OPERATION PERIOD

Direct Habitat Loss, Alteration, or Enhancement

Alternative B would result in the loss of a small amount of habitat under gravel compared to the amount available in the Plan Area. There would be less acreage lost to gravel placement in Alternative B than in Alternative A because there would be no road between CD-2 and CD-6. Muskoxen and moose generally winter south of the Plan Area, and riparian areas are important foraging habitats for them in the summer (TAPS Owners 2001). Under Alternative B there would be less direct loss of riparian habitat within the Plan Area than under Alternative A. Riparian areas are also important to grizzly bears and wolverines (BLM and MMS 2003). Arctic foxes and red foxes adapt to development, so the differences in habitat loss for these species between Alternative A and Alternative B are probably negligible. Small mammals would experience less direct habitat loss with less gravel fill under Alternative B than Alternative A.

The two most important foraging habitat types for caribou in summer are Moist Sedge-Shrub Meadow and Moist Tussock Tundra (Lawhead et al. 2003, Russell et al. 1993, Jorgenson et al. 2003c). The Barrens habitat type primarily provides insect-relief to caribou in summer (Jorgenson et al. 2003c). The most important habitat types for muskoxen include Riverine, Upland Shrub, and Moist Sedge-Shrub Meadow (PAI 2002a; BLM and MMS 2003, and references therein). These habitat types, as well as Barrens, are the most important habitat types for grizzly bears (Shideler and Hechtel 2000; Jorgenson et al. 2003c; PAI 200a2, and references therein). The Riverine and Upland Shrub habitat types are also the most important habitat types for moose. These habitat types potentially lost from gravel fill (roads, pads, and airstrips) under Alternative B are quantified below.

A total of 2,927 acres of Moist Sedge-Shrub Meadow are available in the Colville River Delta (Table 4B.3.3-2). A habitat map is available for 175,861 acres in the National Petroleum Reserve-Alaska, but not for the entire area. The total area of Moist Sedge-Shrub Meadow in the habitat-typed area of the National Petroleum Reserve-Alaska is 42,071 acres (Jorgenson et al. 2003c). A total of 49.6 acres (9.0 acres in the Colville River Delta, 40.6 acres in the National Petroleum Reserve-Alaska) of Moist Sedge-Shrub Meadow would be lost as a result of gravel placement (roads, pads, and airstrips) under Alternative B (Table 4B.3.1-2). The potential loss of Moist Sedge-Shrub Meadow from gravel fill is less than 0.2 percent of that available on the Colville River Delta. The proportional loss of habitat in the National Petroleum Reserve-Alaska cannot be calculated because a habitat map is not available for the National Petroleum Reserve-Alaska area. However, the potential loss under gravel fill in the habitat-typed area in the National Petroleum Reserve-Alaska is 0.1 percent of the Moist Sedge-Shrub Meadow available in that area. In addition to effects of gravel fill, 189.2 acres (60.9 acres in the Colville River Delta, 128.3 acres in the National Petroleum Reserve-Alaska) of the Moist Sedge-Shrub Meadow habitat type would be altered by dust fallout (as calculated for vegetation impacts in Section 4A.3.1).

A total of 525 acres of Moist Tussock Tundra habitat type are available in the Colville River Delta (Table 4B.3.3-2). The total area of Moist Tussock Tundra in the habitat-typed area of the National Petroleum Reserve-Alaska is 49,647 acres (Table 4B.3.3-2). No Moist Tussock Tundra would be lost or altered in the Colville River Delta under Alternative B (Table 4B.3.1-2). A total of 72.5 acres of Moist Tussock Tundra would be lost as a result of gravel placement (roads, pads, and airstrips) in the National Petroleum Reserve-Alaska under Alternative B (Table 4B.3.1-2). The potential loss under gravel fill in the habitat-typed area in the National Petroleum Reserve-Alaska is less than 0.1 percent of that available in that area. In addition to the area affected by gravel fill, 195.2 acres of Moist Tussock Tundra habitat type would be altered by ground related imipacts in the National Petroleum Reserve-Alaska (Table 4B.3.1-2), while no habitat would be altered in the Colville River Delta.

The combined area of Riverine and Upland Shrub habitat types in the Colville River Delta is 7,994 acres (Table 4B.3.3-2). A habitat map is available for 175,152 acres in the National Petroleum Reserve-Alaska, but not for the entire area. The combined area of Riverine and Upland Shrub habitat types in the National Petroleum Reserve-Alaska is 4,778 acres (Table 4B.3.3-2). A total of 6.7 acres of Riverine and Upland Shrub habitat types would be lost as a result of gravel placement (roads, pads, and airstrips) under Alternative B in the Colville River Delta (Table 4B.3.1-2 No Riverine or Upland Shrub habitat types would be lost or altered in the National Petroleum Reserve-Alaska under Alternative B. The potential loss of Riverine habitat type and Upland Shrub habitat type is less than 0.1 percent of that available in the Colville River Delta. In addition to that area affected by gravel fill, 17.9 acres (17.7 acres in the Colville River Delta, 0.2 acres in the National Petroleum Reserve-Alaska) of Riverine and Upland Shrub habitat types would be altered by gravel related impacts (Table 4B.3.1-2).

The total area of Barrens habitat type in the Colville River Delta is 20,993 acres (Table 4B.3.3-2). The total area of Barrens in the habitat-typed area of the National Petroleum Reserve-Alaska is 1,552 (Table 4B.3.3-2). A total of 0.2 acres of Barrens would be lost as a result of gravel placement (roads, pads, and airstrips) in the Colville River Delta, and no Barrens habitat type would be lost or altered in the National Petroleum Reserve-Alaska, under Alternative B (Table 4B.3.1-2). The potential loss of Barrens habitat is less than 0.1 percent of that available in the Colville River Delta. In addition to the area affected by gravel fill in the Colville River Delta, 9.8 acres of Barrens habitat type would be altered by gravel related impacts under Alternative B (Table 4B.3.1-2), while no acreage would be affected in the National Petroleum Reserve-Alaska.

Disturbance and Displacement

Disturbance associated with operations in Alternative B would be less than that described in Alternative A. There would be considerably less vehicle traffic in Alternative B because there would be no road between CD-2 and CD-6. Vehicle traffic is the main cause of disturbance associated with oilfield roads. Conversely, aircraft traffic at two airstrips, CD-5 and CD-6, would be higher in Alternative B than in Alternative A. This would result in more disturbance of caribou, muskoxen, grizzly bears, and moose. This impact could lessen with time, as caribou have habituated to the airstrip at Deadhorse. The placement of CD-6 and the pipeline to it outside the Fish Creek riparian area would result in fewer disturbances in this area. Moose, muskoxen, grizzly bears, and caribou could all use these riparian habitats. Access limited to oilfield workers by the lack of road connections to other oilfields or public roads would result in fewer disturbances than in the other alternatives.

Obstruction to Movements

The primary obstructions to movements of terrestrial mammals in oilfields are roads with traffic and pipelines. Alternative B would probably result in less obstruction to movements of terrestrial mammals than Alternative A. This is because there are only 10 miles of road/pipeline combination in Alternative B, compared to 26 miles of road/pipeline combination in Alternative A. This is 15.8 fewer miles of road/pipeline combination under Alternative B. Roads with pipelines are more of an impediment to caribou movement than either roads or pipelines alone (Cronin et al. 1994, Murphy and Lawhead 2000, TAPS Owners 2001). The pipelines in Alternative B would be elevated to 5 feet, as in Alternative A. This is generally adequate elevation to allow free passage of caribou, although some delay or deflection may occur. The area between CD-2 and CD-6 would have a pipeline without an accompanying road in Alternative B. This would result in less obstruction in summer of theTCH caribou moving east or of the CAH caribou moving west than in Alternative A. The riparian zones of the Nigliq Channel and Ublutuoch River would be crossed by only a pipeline under Alternative B, and movements of muskoxen and moose that frequently use riparian zones would be less affected than in Alternative A. The airstrips at CD-5 and CD-6 could cause some local obstruction of movements of mammals. These airstrips would be easy to circumnavigate compared to long stretches of road/pipeline combinations.

Mortality

With less road and traffic, fewer vehicle-wildlife collisions would be expected in Alternative B compared to Alternative A. As with the other alternatives, standard industry practice, BLM stipulations, and state regulation for Alternative B would include control of garbage and prohibition of intentional feeding of wildlife. This should ensure little or no impact on predator populations that could affect other terrestrial mammals and birds. In Alternative B, road access would be by industry only, so hunting mortality resulting from the road access would not occur.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT IMPACTS ON TERRESTRIAL MAMMALS

The primary characteristic of the Alternative B FFD with regard to impacts on terrestrial mammals is the partial network of roads connecting the facilities. The pipeline routes in Alternative B are similar to those of Alternative A, although there is some different routing among the alternatives to several of the sites in the Fish-Judy Creeks Facility Group. The Alternative B pipelines would be elevated to 5 feet, as in Alternative A, and access to the production sites would be by industry only.

The total amount of gravel fill under Alternative B would be 1,149 acres, versus 1,262 acres for Alternative A, including 461 acres for pads/airstrips, and 588 acres for roads. Because neither detailed site locations nor habitat mapping are available, we cannot quantify specific terrestrial mammal habitat lost under Alternative B.

However, Alternative B has considerably less acreage covered with gravel than Alternatives A or C (for example, 247 acres less than Alternative A) and thus less direct loss of vegetated habitat. More than half (60 percent) of the Alternative B gravel would be roads, with associated impacts.

COLVILLE RIVER DELTA FACILITY GROUP

Characteristics of Alternative B FFD that differ from Alternative A FFD that would potentially affect terrestrial mammals in the Colville River Delta Facility Group are only those associated with differences between these alternatives for the ASDP. The additional FFD Scenario is the same for Alternatives A and B in the Colville River Delta.

Direct Habitat Loss, Alteration, or Enhancement

Under the Alternative B FFD, the amount of habitat directly lost to caribou, moose, and muskoxen for foraging in the Colville River Delta Facility Group would be the same as that associated with the Alternative A FFD.

Disturbance and Displacement

Disturbance and displacement of terrestrial mammals in Alternative B FFD would be comparable to those of Alternative A because the infrastructure would be the same. Alternative B would allow only industry access to roads in the Plan Area, and this would reduce the potential for disturbance and displacement compared to Alternative A.

Obstruction to Movements

Obstructions to movements of terrestrial mammals in Alternative B FFD would be comparable to those of Alternative A because the infrastructure would be the same. Alternative B would allow only industry access to roads in the Plan Area, and this would reduce traffic and the potential for obstruction of movements compared to Alternative A.

Mortality

Mortality associated with Alternative B FFD should be similar to that in Alternative A. Alternative B would allow only industry access to roads in the Plan Area, and this would reduce the potential for vehicle collisions and hunter harvest compared to Alternative A.

FISH-JUDY CREEKS FACILITY GROUP

There are considerable differences in the FFD for Alternatives A and B in the Fish-Judy Creeks Facility Group. Under Alternative B, the HP-3, HP-1, and HP-15 sites would be accessed by a road extending northwest from CD-5. Under Alternative A, HP-1 and HP-15 are accessed by roads from the road between CD-5 and CD-7. There are also different routes in these alternatives proposed to access HP-16, HP-17, HP-10, and HP-19. Most notably, in Alternative B, the hypothetical HPF-1 processing site is farther east of Judy Creek than in Alternative A, and there is no road accompanying the pipelines from HPF-1 to the HP-16 and HP-17 sites or westward to the Kalikpik-Kogru Rivers Group. Another important difference between Alternatives A and B is the industry-only access under Alternative B.

Direct Habitat Loss, Alteration, or Enhancement

There would be considerably less gravel fill covering habitat under Alternative B FFD because there is less roadway being constructed than in Alternative A FFD. The primary locations of roads in Alternative A that are not in Alternative B are between CD-5 and CD-6 (from the ASDP), HPF-1 and HP-16, and HP-16 and HP-18. However, there would be ice roads built annually connecting HPF-1 to HP-16 and HP-18 across Judy Creek and

Fish Creek, respectively. Given the large amount of habitat in the Plan Area and adjacent areas for terrestrial mammals, the impacts from the loss of forage habitat under Alternative B would be limited.

In Alternative B, with annual ice road construction between HPF-1 and HP-16 and between HP-16 and HP-18, direct loss of denning habitats for bears would be similar to Alternative A. Direct loss of summer foraging habitat for muskoxen, moose, and grizzly bears would be less under Alternative B in the Fish-Judy Creeks Facility Group. Grizzly bears have been sighted in the area of the Fish-Judy Creeks Facility Group. Muskoxen are expected to continue expanding their range westward, and moose are primarily associated with riparian habitats on the coastal plain (Shideler and Hechtel 2000, Burgess et al. 2002, BLM and MMS 2003). Effects on winter habitats of wolves, foxes, and small mammals are expected to be similar to those under Alternative A. Loss of riparian habitat near Judy Creek and Fish Creek would be less for Alternative B than for Alternative A. Small mammals would lose less habitat to gravel fill under Alternative B than Alternative A.

Disturbance and Displacement

Because of fewer roads and less traffic in Alternative B, disturbance and displacement of caribou and other terrestrial mammals would be less than in Alternative A. This may be particularly true along Fish Creek and Judy Creek because some of the facilities are farther from the creeks in Alternative B. There would still be some level of disturbance of caribou and other mammals during the summer and winter seasons, considering the road and aircraft traffic and human activity at the production pads and processing facilities. Past surveys have found that few caribou calved in this area, so disturbance during the calving period would be similar in Alternatives A and B. Airstrips at CD-6, HP-17, and APF-2 would cause temporary disturbances to caribou. Also, disturbances to grizzly bears and muskoxen from aircraft would be greater under Alternative B than under Alternative A. Because road access is restricted to industry only in Alternative B, habituation of caribou and other mammals to industry-related activities is likely within the Plan Area because there would be less traffic and hunting by local residents.

Obstruction to Movements

Movements of caribou would be less obstructed under Alternative B than Alternative A because there would be fewer roads under Alternative B. The corridors from HPF-1 to HP-16 and HP-16 to HP-18 would have only pipelines, and obstruction of movements is less likely than if there were roads with traffic. Also, in Alternative B, HP-16, HP-17, and HP-19 would not be accessed from the north along Judy Creek but instead from roads farther offset from the creek. This may mitigate potential obstruction of movements of terrestrial mammals (such as moose, muskoxen, and grizzly bears) using the riparian zone. However, data from May 2002 (Burgess et al. 2003) suggest that more wintering caribou could be exposed to an access road to HP-19 from HP-10, as proposed in Alternative B.

Caribou movements toward the coast could be obstructed by the road/pipeline from CD-5 to HP-15 in Alternative B. However, Alternative B would have less traffic (traffic would be restricted to industry only) and thus less potential obstruction of movements of caribou and other species than Alternative A. Grizzly bears, muskoxen, and moose use riparian corridors for foraging and travel, and Alternative B would reduce road development near Fish Creek and Judy Creek, potentially reducing negative impacts on movements.

Mortality

In Alternative B, with annual ice roads constructed from HPF-1 to HP-16 and on to HP-18, the probability of collisions with vehicles in winter would be similar to Alternative A. The limited new gravel roads in the area would reduce the probability of vehicle collisions in Alternative B. The restriction of road access to industry would further reduce the likelihood of vehicle-caused mortality and hunter harvest.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

The primary difference between Alternatives A and B in this area is that HP-22 and its associated pipeline planned for Alternative A are not included in Alternative B. This removes potential impacts during construction, winter ice road use, and activity on the HP-17 site.

Direct Habitat Loss, Alteration, or Enhancement

Habitat loss would be the same as in Alternative A, except that habitat would not be lost at HP-22. There would be no ice road associated with construction of a pipeline to that pad. Habitat would be lost under the facilities at HP-18, HP-20, HP-21, and HPF-2, and the roads among them. This could entail loss of some calving, post-calving, and winter habitats for caribou.

Disturbance and Displacement

The construction and operational activity in this area could disturb caribou and other species. Caribou occur in this area during the calving period and disturbance from traffic on roads, aircraft, and other activity could result in displacement. Timing of activities and controlling traffic could mitigate impacts during the calving period. An airstrip at HPF-3 would cause temporary disturbances to caribou and other species.

Obstructions to Movement

The entire area has been occupied by caribou during calving, post-calving, and winter seasons in the past (Figures 3.3.4.1-1, 3.3.4.1-2, and 3.3.4.1-6). The area just south of the Kogru River has supported relatively high densities of wintering caribou (BLM and MMS 2003). It is possible that the road/pipeline complexes in the Alternative B FFD would obstruct or deflect caribou movements to some extent. The use of pipelines elevated to 5 feet and separation of roads and pipelines by more than 300 feet would mitigate this impact.

In Alternative B, large groups of TCH caribou in the area during calving and the summer season would not encounter a pipeline from HP-21 to HP-22 (as proposed in Alternative A) south of the Kogru River. Although elevated pipelines are not usually a barrier to movement, the lack of the pipeline and HP-22 facility in Alternative B reduces the potential for deflection and delay of movements.

Mortality

There could be some mortality of terrestrial mammals associated with road traffic under Alternative B. Limiting road access to industry would likely limit this impact. The smaller amount of road under Alternative B compared to Alternative A would also reduce this impact.

ABANDONMENT AND REHABILITATION

The impacts from abandonment and rehabilitation on terrestrial mammals under Alternative B would be similar to those for Alternative A. There would be a couple differences, though, primarily affecting terrestrial mammals and habitat west of the Nigliq Channel. Because there is no gravel road between CD-2 and CD-6, there would be less summer traffic and more winter traffic associated with dismantlement of above ground facilities located on pads, and consequently fewer impacts would be expected to muskoxen, moose, and grizzly bears. Air traffic impacts would be increased. Finally, the lack of a road between CD-2 and CD-6 would mean that abandonment would entail less disturbance compared with Alternative A along the corridor used by the road in the latter alternative.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON TERRESTRIAL MAMMALS

The CPAI Development Plan Alternative B would cover 204 acres of undeveloped land with gravel fill. This is a small percentage of the land in the Plan Area, and 65 fewer acres than Alternative A. The amount of habitat types preferred by caribou, muskoxen, and moose that would be affected by this fill is a small proportion (less than 0.1 percent) of that available in the Plan Area. Alternative B would result in a small direct loss of terrestrial mammal habitat.

Disturbance, obstruction of movements, and mortality impacts of Alternative B would be similar to those of Alternative A. However, these impacts would be of less magnitude in Alternative B than in Alternative A because of the smaller amount of road/pipeline combinations and associated lower levels of vehicle traffic. Alternative B includes access restricted to industry, so the disturbance and hunting mortality from local resident access would not occur. The potential positive and negative aspects of hunting mortality described for Alternative A would not occur.

Alternative B FFD would cause the same impacts as those described for the CPAI Development Plan over a larger area. An exception is the potential for increased disturbance of calving caribou of the TCH in the northwestern part of the Plan Area.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR TERRESTRIAL MAMMALS

Appropriate mitigation measures for Alternative B will be essentially the same as those described for Alternative A. The lack of a road alongside the pipeline between CD-2 and CD-7 might make buried pipeline sections unnecessary.

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR TERRESTRIAL MAMMALS

The effectiveness of the protective measures would be similar to Alternative A.

4B.3.4.2 Marine Mammals

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON MARINE MAMMALS

Two components of Alternative B differ from Alternative A and would affect marine mammals. First, in Alternative B, there is no road bridge over the Nigliq Channel between CD-2 and CD-5. A pipeline bridge would still be constructed. Second, Alternative B includes airstrips at CD-5 and CD-6 that are not included in Alternative A.

RINGED SEAL AND BEARDED SEAL

The impacts to ringed seals and bearded seals under Alternative B would be similar to those occurring under Alternative A during both construction and operation of the ASDP. The additional airstrips in Alternative B could result in greater air traffic over the nearshore Beaufort Sea that could disturb seals. Large oil spills could have effects that are far-reaching enough to affect seals. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, Section 4.3.

SPOTTED SEALS

The impacts to spotted seals expected under Alternative B would be less than those expected under Alternative A. The elimination of the road bridge over the Nigliq Channel would remove the potential disturbance of seals by construction and vehicle traffic. Hunter access would not be enhanced (as it would under

Alternative A) without the road/bridge at the Nigliq Channel. Construction impacts would be the same as under Alternative A because the pipeline bridge would still be built across Nigliq Channel. There is also the potential for increased disturbance from air traffic at CD-5 and CD-6 under Alternative B.

During construction and drilling, access to CD-5 would be by an ice road and ice bridge during the winter and by aircraft and low-ground-pressure vehicles during the summer. During the operation period, vehicular traffic between CD-2 and CD-5 would be eliminated during the summer under Alternative B. There would probably be an ice road over the Nigliq Channel each winter. Because spotted seals occur in the Beaufort Sea only in the open-water seasons of summer and early fall (PAI 2002a), disturbance from vehicle traffic would not occur. Access limited to industry would not allow increased access by hunters.

Aircraft traffic over the Nigliq Channel would increase as a result of the elimination of the road bridge. Several flights per week would be necessary to transport personnel and equipment to CD-5, CD-6, and CD-7. Flight elevations of less than 1,000 ft are anticipated to be over land areas within 3.6 miles northeast and southwest of the airstrip at CD-3. Thus, aircraft would cross the Nigliq Channel at a minimum of 1,000 feet altitude. At such elevation, the potential to affect spotted seals is substantially reduced. Therefore, no additional impacts to spotted seals are expected to result from the increased aircraft traffic under Alternative B. Large oil spills could have effects that are far-reaching enough to affect spotted seals. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, Section 4.3.

POLAR BEARS

The impacts to polar bears under Alternative B would be generally similar to those occurring under Alternative A during both construction and operation of the ASDP. However, the reduced road mileage in Alternative B would reduce the probability of vehicle-bear collisions and human-bear contact. Hunter access is not enhanced under Alternative B, so less mortality would result. Large oil spills could have effects that are far-reaching enough to affect polar bears. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, Section 4.3.

BELUGA WHALES

The impacts to beluga whales expected under Alternative B would differ from those of Alternative A because of the lack of road bridge over the Nigliq Channel and increased air traffic to CD-5 and CD-6. As with spotted seals, belugas may occur offshore of the Plan Area in the open water season. Therefore, there would be reduced potential for vehicle disturbance and hunter access under Alternative B. Increased air traffic could cause some disturbance, but altitude restrictions would minimize this. Potential disturbance impacts to belugas during the construction period could occur during the construction of the pipeline bridge across the Nigliq Channel. Large oil spills could have effects that are far-reaching enough to affect beluga whales. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, Section 4.3.

ABANDONMENT AND REHABILITATION

Impacts of abandonment and rehabilitation under Alternative B would be similar to that for Alternative A.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON MARINE MAMMALS

Full-field development under Alternative B calls for the same production pads as Alternative A in the Colville River Delta Facility Group and the Fish-Judy Creeks Facility Group but eliminates HP-22 in the Kalikpik-Kogru Rivers Facility Group. There is an alternate road route from HP-3 to HP-15. The impacts to marine mammals expected under Alternative B would not be appreciably different from impacts expected under Alternative A FFD. Exceptions include the potential that impacts from HP-22 and local access (hunter access) under Alternative A would not occur under Alternative B.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON MARINE MAMMALS

Impacts to marine mammals under Alternative B would include potential disturbance of seals and polar bears by noise during construction and operations. The limited roads, including no road over the Nigliq Channel, suggests there would be less disturbance from vehicles and more disturbance from aircraft traffic than in Alternative A. There would not be access by local residents, so increased hunting harvest would not occur.

Impacts from the Alternative B FFD would have the same impacts described for the CPAI Development Plan over a larger area.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR MARINE MAMMALS

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.3.4).

ALTERNATIVE B – EFFECTIVENESS OF PROTECTIVE MEASURES FOR MARINE MAMMALS

The effectiveness of the protective measures would be similar to Alternative A.

4B.3.5 Threatened and Endangered Species

4B.3.5.1 Bowhead Whale

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON BOWHEAD WHALE

Bowhead whales are generally not found in the Plan Area. During spring migration, bowheads are found far offshore in the lead system of the Beaufort Sea. During fall migration, most bowheads pass north of a line from Cape Halkett to Oliktok Point. Large oil spills could have effects that are far-reaching enough to affect bowhead whales. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, Section 4.3. Other activities that would occur in the Plan Area under all CPAI alternatives would not affect the bowhead whale population, habitat, migration, foraging, breeding, survival and mortality, or critical habitat.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON BOWHEAD WHALE

Construction of a processing facility for FFD might require a sealift to transport processing facilities. This could result in impacts to bowhead whales from noise, pollution, disturbance, and vessel strikes. However, the use of docks was determined not to be a practical means of developing the facilities proposed by CPAI or during future development (Section 2.6.4), so the use of sealifts is uncertain. Aircraft noise could also disturb bowheads.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON BOWHEAD WHALE

The potential impacts from Alternative B would be the same as those for Alternative A. This is also the case under FFD Alternative B, although the additional airstrips compared to Alternative A would lead to increased aircraft noise.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR BOWHEAD WHALE

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.3.5).

4B.3.5.2 Spectacled Eider

See discussions of impacts on spectacled eiders in Section 4A.3.5.2 for additional descriptions of impact mechanisms and for description of impact calculation assumptions and methods.

ALTERNATIVE B – CPAI DEVELOPMENT PLAN IMPACTS ON SPECTACLED EIDER

Table 4A.3.5-1 presents the estimated number of nests displaced as a result of habitat loss, alteration and disturbance for the CPAI Development Plan Alternative B. In CPAI Alternative B, facilities would be moved outside of the 3-mile sensitive area around Fish Creek, and power lines on poles would be replaced by power lines on cable trays on VSMs.

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

The proposed infrastructure in the CD-3 and CD-4 areas under Alternative B is the same as that proposed for those sites under Alternative A. Potential impacts to spectacled eiders from habitat loss and alteration at the CD-3 and CD-4 sites would be the same as those discussed for Alternative A. At the CD-5, CD-6, and CD-7 sites, the overall amount of habitat lost because of gravel placement under Alternative B would be reduced compared to Alternative A by the elimination of the road connecting CD-6 with CD-5 and the Nigliq Channel road bridge.

Impacts to spectacled eiders related to habitat loss and alteration would be the same as those described for Alternative A. The area covered by gravel and lost as potential spectacled eider habitat would be reduced in Alternative B from Alternative A. Impacts to habitats important to spectacled eiders indicate that the total area of gravel cover for Patterned and Nonpatterned Wet Meadow habitats used by nesting spectacled eiders would be reduced in Alternative B compared to Alternatives A, C, and D in the Colville River Delta (Table 4A.3.5-2). Gravel cover impacts on open water habitat preferred by pre-nesting spectacled eiders and used by nesting spectacled eiders would be decreased in Alternative B compared to Alternatives A, C, and F in the National Petroleum Reserve-Alaska portion of the Plan Area (Table 4A.3.5-3). Gravel impacts on Old Basin Wetland Complex and Patterned Wet Meadow habitats used by spectacled eiders for nesting in the National Petroleum Reserve-Alaska would be reduced in Alternative B compared to Alternatives A, C, and F (Table 4A.3.5-3). Impacts to spectacled eider habitat from dust would be reduced by the elimination of roadways in Alternative B, although impacts from ice roads would be increased during the construction period. An estimated 0.6 spectacled eider nests affected by gravel fill related impacts and 0.1 spectacled eider nests would be affected by ice road impacts in Alternative B. In all cases, the proportion of available habitat used by spectacled eiders and affected by gravel fill-related impacts in the Colville River Delta and in the National Petroleum Reserve-Alaska portion of the Plan Area would be less than 1 percent (Table 4A.3.5-2 and Table 4A.3.5-3).

Disturbance and Displacement

Fewer spectacled eiders would be displaced by vehicle traffic in Alternative B compared to Alternative A as a result of the reduction in the road system. Addition of the airstrip at CD-5 and CD-6 would cause additional disturbance compared to Alternatives A and C, affecting an estimated additional 0.3 spectacled eider nests. This additional disturbance would occur in areas with low spectacled eider densities.

Obstructions to Movement

Potential obstruction of movement would be reduced in Alternative B compared to Alternative A by the removal of the road between CD-2 and CD-5 to CD-6. The general reduction in gravel fill would result in a reduction in potential obstruction of movements for brood-rearing spectacled eiders.

Mortality

Mortality resulting from collisions with vehicles would be reduced in Alternative B from Alternative A with the reduction in the road system. Mortality resulting from collisions with aircraft would be increased with the two additional airstrips. Mortality resulting from collisions with power lines on poles would be reduced in Alternative B from Alternative A by placement of the power lines on pipeline VSMs between CD-6 and CD-7.

Spectacled eider nesting success in the Plan Area was generally low (33 percent) (Johnson et al. 2004). Any increase in predator populations attracted to the development areas would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to spectacled eiders because they are known to nest in specific locations year after year and have a low total population size.

OPERATION PERIOD

Habitat Loss and Alteration

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. These impacts would be reduced in Alternative B compared to Alternative A because of the reduced amount of gravel fill (Table 4A.3.5-2 and Table 4A.3.5-3).

Disturbance and Displacement

The effects of disturbance on spectacled eiders under Alternative B in the CD-3 and CD-4 areas would be the same as those described previously for Alternative A. At the National Petroleum Reserve-Alaska sites, the overall disturbance to spectacled eiders from vehicular traffic and other disturbances associated with roads would be reduced compared to Alternative A by the elimination of the road connecting CD-6 with CD-5 and the Nigliq Channel road bridge. Disturbance related to aircraft could be increased at the CD-5 and CD-6 sites by the addition of airstrips; spectacled eiders have been recorded nesting near the proposed CD-5 site.

Obstructions to Movement

Under Alternative B, any potential obstruction to movements of spectacled eiders in the CD-3 and CD-4 areas would be the same as that discussed above for Alternative A. At the proposed National Petroleum Reserve-Alaska sites, any potential obstruction to spectacled eider movement resulting from road placement would be reduced compared to Alternative A by the elimination of the road connecting CD-6 with CD-5 and the Nigliq Channel road bridge to CD-2.

Mortality

Under Alternative B, the potential for spectacled eider mortality related to collisions with vehicular traffic at the CD-3 and CD-4 sites would be the same as under Alternative A. At the National Petroleum Reserve-Alaska sites, the potential for eider collisions with vehicular traffic would be reduced compared to Alternative A because of the elimination of the roads connecting the CD-6 site with CD-5 and the Nigliq Channel bridge and road to CD-2. Potential mortality from collisions with aircraft would increase in Alternative B compared to Alternative A with the addition of airstrips at CD-5 and CD-6. The potential for spectacled eider mortality from collisions with power lines on poles would be decreased in Alternative B compared to Alternative A as a result of the placement of all power lines on VSMs. The potential for increased depredation from raptors or ravens on spectacled eider nests would also be decreased in Alternative B compared to Alternative A by the elimination of poles that could improve foraging efficiency of raptors and ravens by providing additional vantage locations.

ALTERNATIVE B – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SPECTACLED EIDER

The mechanisms associated with habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups would be the same as those described under Alternative A (Section 4A.3.5.2). Potential impacts are summarized for Alternative B FFD based assumptions and calculation methods presented in Section 4A.3.5.2 for estimated numbers of spectacled eider nests affected in the Colville River Delta and the National Petroleum Reserve-Alaska. Under Alternative B of the FFD, all facilities would be moved outside of the 3-mile buffer around Fish Creek. Roads would link many of the production pads in the Fish-Judy Creeks and Kalikpik-Kogru Rivers facility group areas, although airstrips would be situated at several sites. In the Colville River Delta Facility Group, the proposed facilities for FFD would be the same as those discussed for the FFD under Alternative A. The effects of FFD on spectacled eiders would depend on the location and extent of development in specific locations within each area. Habitat related impacts by vegetation class for FFD Alternative B are summarized in Table 4B.3.5-1 by facility group.

COLVILLE RIVER DELTA FACILITY GROUP

A summary of the estimated number of spectacled eider nests affected by the hypothetical FFD including the Colville River Delta Facility Group area is presented in Table 4A.3.5-4.

Habitat Loss, Alteration, or Enhancement

Total habitat loss and alteration resulting from gravel placement and mining would be similar in Alternative B FFD compared to Alternative A FFD. Habitat related impacts would affect an estimated 2.6 spectacled eider nests (Table 4A.3.5-4). Ice roads and dust fallout would also be similar in Alternative B and Alternative A, affecting an estimated 0.3 spectacled eider nests (Table 4A.3.5-4).

Disturbance and Displacement

Potential disturbance and displacement by vehicle traffic at CD-4, HP-4, and HP-5 would be reduced in Alternative B FFD compared to Alternative A FFD because of elimination of the road between CD-2 and CD-5 allowing access to the Delta from Nuiqsut. This would reduce potential traffic from the local community to these facilities. Disturbance related to air traffic in the Colville River Delta Facility Group would be the same as Alternative A, affecting an estimated 4.0 spectacled eider nests (Table 4A.3.5-4).

Obstructions to Movements

Obstructions to bird movements would be reduced in Alternative B FFD compared to Alternative A FFD by the elimination of the road connecting CD-2 to CD-5. All other FFD components are similar in these two alternatives.

Mortality

Mortality from collisions with vehicles would be reduced by the reduction in the road system between Alternative B FFD and Alternative A FFD. Mortality from collisions with aircraft would be the same for Alternative B and Alternative A. Potential mortality from hunting would be reduced in Alternative B FFD compared to Alternative A FFD if increased access to Nuiqsut by the road between CD-2 and CD-5 contributed to increased harvest. Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified.

FISH-JUDY CREEKS FACILITY GROUP

A summary of the estimated number of spectacled eider nests affected by the hypothetical FFD including the Fish-Judy Creeks Facility Group is presented in Table 4A.3.5-4.

Habitat Loss, Alteration, or Enhancement

Under Alternative B FFD in the Fish-Judy Creeks Facility Group, the overall amount of habitat loss would be reduced compared to Alternative A because of the decrease in the road system and the elimination of one well pad. The construction of airstrips would increase habitat loss in the immediate areas of CD-6 and HP-17. Habitat related impacts would affect an estimated 1.4 spectacled eider nests (Table 4A.3.5-4). Vegetation classes used by spectacled eiders that would receive decreased gravel fill related impacts compared to Alternative A are Fresh Sedge Marsh, Old Basin Wetland Complex and Wet Sedge Meadow Tundra (Table 4B.3.5-1 and Table 4A.3.5-5).

Obstructions to Movements

Obstructions to movements of brood-rearing birds would be reduced in Alternative B FFD compared to Alternative A FFD by the reduction in the road system.

Disturbance and Displacement

Disturbance from vehicle traffic would be reduced in Alternative B FFD compared to Alternative A FFD by the reduction in the road system and reduced access for local traffic. Disturbance from air traffic would be increased by the addition of airstrips at CD-5, CD-6, and CD-24. Disturbance of spectacled eiders by facility noise would be reduced by moving HPF-1 from an area of 0.01 to 0.11 birds/km^2 to an area of less than 0.01 birds/km^2. The greatest potential for vehicular traffic to affect spectacled eiders likely would occur in the vicinity of CD-6 and HP-1, along the access road from HP-1 to HP-15 where higher densities of spectacled eiders might occur (Figure 3.3.5.2-1).

At CD-6, the potential for aircraft disturbance to affect spectacled eiders would probably be increased compared to Alternative B of the ASDP because of the increased number of well pads and the HPF-1 facility that would receive support from the airstrip at that site. The addition of the airstrip at the HP-17 site might have little effect on spectacled eiders because of the lower number of eiders in that area compared to the CD-6 and CD-8 areas (Figure 3.3.5.2-1). Air traffic disturbance would affect an estimated 0.5 spectacled eider nests (Table 4A.3.5-4).

Mortality

Mortality from collisions with vehicles would be reduced in Alternative B FFD compared to Alternative A FFD by the reduction in the road system and removal of access for local traffic. Mortality from collisions with aircraft would be increased by the addition of airstrips at CD-5, CD-6, and HP-17. Local access to Nuiqsut would be eliminated for Alternative B FFD compared to Alternative A FFD to pad locations adjacent to the Colville River and Harrison Bay, potentially reducing subsistence waterfowl harvest if increased access to these areas would lead to increased harvest. Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified.

TABLE 4B.3.5-1 ALTERNATIVE B – SUMMARY OF AFFECTED VEGETATION CLASSES FOR FFD USED BY SPECTACLED EIDERS

Vegetation Classes	Colville River Delta Facilities Group[a]		Fish-Judy Creeks Facility Group[a]		Kalikpik-Kogru Rivers Facility Group[a]		Grand Total	Plan Area Totals[b]		Spectacled Eider Habitats
	Loss (acres)	**Alteration (acres)**	**Loss (acres)**	**Alteration (acres)**	**Loss (acres)**	**Alteration (acres)**		**Acres**	**Percent Affected**	
Riverine Complex	0.1	0.8	0.6	3.0	0.0	0.0	4.5	698.3	1%	
Fresh Grass Marsh	1.0	4.5	26.2	153.3	12.8	76.5	274.2	2583.7	11%	√
Fresh Sedge Marsh	<0.1	<0.1	19.9	44.8	7.9	11.3	93.2	40953.6	<1%	√
Deep Polygon Complex	4.6	10.8	26.1	46.9	8.9	14.5	109.7	55208.0	<1%	√
Young Basin Wetland Complex	0.4	2.5	48.4	245.3	17.7	89.3	402.8	22910.8	2%	
Old Basin Wetland Complex	0.9	5.5	20.7	92.7	2.0	12.3	132.9	15674.5	1%	√
Wet Sedge Meadow Tundra	100.6	319.5	114	485.8	60.6	199.2	1280.5	185820.8	1%	√
Salt-Killed Wet Meadow	12.4	25.3	0.0	0.0	0.0	0.0	37.7	6368.7	1%	√
Halophytic Sedge Wet Meadow	9.3	19.0	0.0	0.0	0.0	0.0	28.3	4453.2	1%	√
Halophytic Grass Wet Meadow	0.3	0.8	0.0	0.0	0.0	0.0	1.1	398.3	<1%	√
Moist Sedge-Shrub Tundra	12.6	53.0	45.2	198.7	4.0	24.2	335.0	44405.7	1%	
Tussock Tundra	5.3	27.9	144	531.6	96.0	439.1	1238.6	208178.9	1%	
Dryas Dwarf Shrub Tundra	0.3	0.7	0.5	0.9	0.0	0.0	2.4	1358.6	<1%	
Cassiope Dwarf Shrub Tundra	2.2	13.4	93.9	562.1	63.8	381.3	1116.8	7734.0	14%	
Halophytic Willow Dwarf Shrub Tundra	0.1	0.1	0.0	0.0	0.0	0.0	0.2	143.1	<1%	√
Open and Closed Low Willow Shrub	19.7	60.0	8.9	46.7	5.6	33.2	173.8	13557.3	1%	
Open and Closed Tall Willow Shrub	<0.1	<0.1	0.5	2.7	<0.1	0.1	3.6	687.2	1%	
Dune Complex	0.0	0.0	3.3	5.5	0.7	1.0	10.1	5913.9	<1%	
Partially Vegetated	10.3	26.6	2.9	10.3	1.5	5.1	56.7	10149.3	1%	
Barrens	36.7	85.5	5.1	11.5	4.0	15.6	158.1	44009.2	<1%	
Totals	**216.7**	**655.8**	**525.2**	**2441.9**	**285.4**	**1302.6**	**5449.1**	**671207.1**	**1%**	

Notes:

[a] Totals from Tables 4B.3.1-3 and 4B.3.1-4

[b] Totals from Table 3.3.1-1 (no data, shadows and water categories not included)

KALIKPIK-KOGRU RIVERS FACILITY GROUP

A summary of the estimated number of spectacled eider nests affected by the hypothetical FFD including the Kalikpik-Kogru Rivers Facility Group is presented in Table 4A.3.5-4.

Habitat Loss and Alteration

Under Alternative B FFD, the potential for habitat loss and alteration to affect spectacled eiders in the Kalikpik-Kogru Rivers Facility Group would be slightly reduced compared to Alternative A because of the elimination of the production pad and airstrip at HP-22. The addition of an airstrip at the HPF-2 site would increase habitat loss in the immediate area of that facility. Increased ice road construction resulting from the elimination of road access would increase temporary habitat alteration during construction and drilling compared to Alternative A FFD. Impacts related to habitat loss would affect an estimated 0.7 spectacled eider nests. Habitat impacts for vegetation classes used by spectacled eiders would be decreased for Fresh Sedge Marsh and Wet Sedge Meadow Tundra and increased for Old Basin Wetland Complex compared to Alternative A FFD (Table 4B.3.5-1 and Table 4A.3.5-5)

Disturbance and Displacement

Disturbance from vehicle traffic would be reduced in Alternative B FFD compared to Alternative A FFD because of the reduced road system. Disturbance from air traffic would be similar in Alternative B FFD and Alternative A FFD, although more spectacled eiders could be affected by the airstrip at HPF-2 compared to the airstrip at HP-22 in Alternative A FFD (Figure 3.3.5.2-1).

Obstruction to Movement

Under Alternative B FFD, any potential obstruction to movement of spectacled eiders might be slightly reduced compared to Alternative A FFD by the elimination of the HP-22 site and associated pipeline.

Mortality

Mortality from collisions with vehicles would be reduced as a result of the reduction in the road system in Alternative B FFD compared to Alternative A FFD, in addition to the reduction in access to local traffic for this alternative. Mortality from collisions with aircraft would be similar in Alternative B FFD and Alternative A FFD, although fewer seabirds might be affected by placement of the airstrip at HPF-2 rather than HP-22. The potential for increased access for subsistence hunting to affect birds would be reduced compared to Alternative A FFD because of the elimination of access roads to the Kalikpik-Kogru Rivers Facility Group. Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear, and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified.

ALTERNATIVE B – SUMMARY OF IMPACTS (CPAI AND FFD) ON SPECTACLED EIDER

Impacts to spectacled eiders associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Spectacled eiders occur in greater numbers near proposed developments in the Colville River Delta than in the National Petroleum Reserve-Alaska portion of the Plan Area. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests affected by habitat loss, alteration and disturbance for each alternative, based on site specific nesting densities for spectacled eiders to compare alternative development scenarios. Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative B would reduce nesting by 4 percent for the Plan Area spectacled eiders. FFD Alternative B would reduce nesting by 21 percent for Plan Area spectacled eiders and less than 1 percent for the North Slope population. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snow drifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The results of effects of these activities on estimated spectacled eider production due to loss, alteration or disturbance of nesting habitat for CPAI Development Plan Alternative B is presented in Table 4A.3.5-1 and for the FFD is presented in Table 4A.3.5-4. Impacts from CPAI Alternatives A through F on habitats used by spectacled eiders are summarized in Table 4A.3.5-2 and Table 4A.3.5-3. Summaries of vegetation classes affected directly and indirectly by gravel fill for FFD Alternative B are presented in Table 4B.3.5-1.

ALTERNATIVE B – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SPECTACLED EIDER

Potential mitigation measures would the same as those identified for Alternative A (Section 4A.3.5.2).

4B.3.5.3 Steller’s Eider

This section describes the potential impacts of the ASDP on threatened Steller’s eiders. Impacts to other bird groups associated with the proposed development are described in Section 4A.3.3 and can be referred to for a more detailed description of the mechanisms of specific impacts. In general, impacts to Steller’s eider potentially are the same as those described for spectacled eider under all of the alternatives. However, the likelihood of impacts occurring to Steller’s eiders is very small, even under FFD scenarios, because Steller’s eiders occur very rarely in the Plan Area. There would be a loss of potential Steller’s eider habitat from the ASDP. Given the current distribution of Steller’s eider in the Plan Area it is unlikely that any of the project alternatives would affect this species.

4B.3.5.4 Abandonment and Rehabilitation

The impacts of abandonment and rehabilitation on threatened and endangered species would be similar to those for Alternative A because there would be little or no change in activities in the area of highest use by these species.

4B.3.5.5 Alternative B – Effectiveness of Protective Measures for Threatened and Endangered Species

The effectiveness of the protective measures would be similar to Alternative A.

4B.4 SOCIAL SYSTEMS

4B.4.1 Socio-Cultural Characteristics

4B.4.1.1 Alternative B – CPAI Development Plan Impacts on Socio-Cultural Characteristics

Socio-cultural impacts under the Alternative B – CPAI Development Plan would generally be similar to those under the Alternative A – CPAI Development Plan. Under Alternative B, oil production is expected to be lower due to the relocation of CD-6. The reduction in oil production will cause a proportional decrease in some economic benefits to the local communities, especially Nuiqsut (see discussion of impacts in Section 4B.4.2).

Changes in infrastructure (reduced length of road construction but offsetting increase in airstrips and aircraft operations) are not expected to materially change the extent of impacts to subsistence harvest and any potential indirect impacts to community health and welfare.

ABANDONMENT AND REHABILITATION

Impacts will be similar to those under Alternative A, however, it is less likely that Nuiqsut residents would have become accustomed to using the oilfield roads to access subsistence resources.

4B.4.1.2 Alternative B – Full-Field Development Scenario Impacts on Socio-Cultural Characteristics

Socio-cultural impacts under the Alternative B – Full-Field Development Scenario are expected to be the same as those under Alternative A – Full-Field Development Scenario. Under Alternative B, oil production is expected to be lower due to the relocation of two pads, elimination of two proposed pads, and the potential that an APF would be uneconomic to develop with the stipulations imposed (see discussion in Section 4B.4.2). The reduction in oil production will cause a proportional decrease in some economic benefits to the local communities, especially Nuiqsut.

4B.4.1.3 Alternative B – Summary of Impacts (CPAI and FFD) on Socio-Cultural Characteristics

Impacts to socio-cultural characteristics under Alternative B – CPAI Development Plan and Alternative B – Full-Field Development are expected to be the same as those under Alternative A – CPAI Development Plan and Alternative A – Full-Field Development with the exception of a potential for reduced economic activity.

4B.4.1.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Socio-Cultural Characteristics

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.4.1.4).

4B.4.1.5 Alternative B – Effectiveness of Protective Measures for Socio-Cultural Characteristics

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.2 Regional Economy

4B.4.2.1 Alternative B – CPAI Development Plan Impacts on Regional Economy

Economic impacts for Alternative B – CPAI Development Plan would be similar to those determined for the Alternative A – CPAI Development Plan except that oil production may be lower in certain years and capital costs would increase by approximately $89 million (8.4percent). Alternative B reflects adherence to several setback stipulations related to production pad location that could reduce the amount of oil produced from the ASDP. Under Alternative B, the BLM projects a potential reduction of between 10 and 30 percent in production from CD-6 as a result of moving the production pad outside the 3-mile setback for Fish Creek. The effect of this variation in pad location was calculated by taking the production stream projected for CD-6 in Table 4A4.2-1 and reducing it by 20 percent, the midpoint of the 10 to 30 percent estimate. The result of this calculation, taken over the period of production for CD-6, results in an overall reduction of 4.15 percent of the total production from the ASDP units CD-3 through CD-7. The economic impacts of Alternative B – CPAI Development Plan would be reduced by that factor.

ABANDONMENT AND REHABILITATION

Employment created by removing facilities and rehabilitation of the land may be comparable to that during construction if gravel fill is removed. Once oil ceases to flow from the satellites and termination activities are complete, economic stimulus from the satellites—with the exception of relatively insignificant employment from monitoring and long-term rehabilitation—would cease.

4B.4.2.2 Alternative B – Full-Field Development Scenario Impacts on Regional Economy

Under the Alternative B – Full-Field Development Scenario, hypothetical HP-22 would be eliminated because of the requirement for setback from the Teshekpuk Lake surface protection area. Permanent facilities would also be precluded by setbacks at Fish Creek and Judy creeks. These relatively narrow setbacks normally would not deny oil companies access to oil. However, oil accumulations centered within a large setback area such as that for Fish Creek may not be able to be reached economically with currently available technology. In the hypothetical scenario for Alternative B, HPF-1, HP-10, and HP-19 would likely be uneconomical to develop. Therefore, the production scenario for the Alternative B – Full-Field Development Scenario must be adjusted to eliminate production from HPF-1, HP-10, HP-19, and HP-22.

Applying this change to full-field production estimates results in an overall production over the period from 2008 through 2055 that is 25 percent lower than the production estimate for Alternative A – Full-Field Development Scenario.

4B.4.2.3 Alternative B – Summary of Impacts (CPAI and FFD) on Regional Economy

Overall economic impacts of Alternative B would be similar to but less than those that result from Alternative A, as described below.

Because most economic impacts associated with project development are directly proportional to oil production, the revenue and employment effects of Alternative B would be lower than for Alternative A. For Alternative B – CPAI Development Plan, the economic impacts would be reduced by approximately 4.15 percent from those estimated for the Alternative A – CPAI Development Plan. For FFD, economic impacts would be reduced by approximately 25 percent.

4B.4.2.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Regional Economy

Potential mitigation measures would be the same as identified for Alternative A (Section 4A.4.2.5).

4B.4.2.5 Alternative B – Effectiveness of Protective Measures for Regional Economy

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.3 Subsistence

4B.4.3.1 Alternative B – CPAI Development Plan Impacts on Subsistence

Effects for similar components in Alternative A – CPAI Development Plan would be the same for Alternative B – CPAI Development Plan (gravel mines, pads, roads, and pipelines outside the Fish and Judy creeks sensitive area) and are not specifically discussed in this section. This section focuses on Alternative B components that are different from those in Alternative A.

CONSTRUCTION PERIOD

Eliminating the road bridge across the Nigliq Channel and roads between CD-2 and CD-6 will require use of an ice bridge across the channel and ice road or low-pressure vehicle travel west of the channel. Subsistence hunters believe that low-pressure vehicles divert game from the areas in which these vehicles operate at a time when the animals are already under stress. One hunter described the effect of Caterpillar and Rolligon trains on winter caribou:

> "At first, there were a lot of caribou. As we worked, using more and more vehicles, the caribou moved out of their prime feeding area. This year the caribou were skinny. Their prime feeding area was invaded, and the herd had to move to a place where there was more heavy snow and they had to dig for food." (SRB&A, 2003a, Field Interviews)

Construction of infrastructure at the Nigliq Channel during winter (pipeline bridge, ice bridge and road) would increase industry traffic in that area. In addition, the Nigliq Channel ice bridge and road would be constructed annually. The Nigliq Channel is an important current and historical subsistence-use area for multiple resources for residents of Nuiqsut and, occasionally, Barrow. This area is especially important to residents of Nuiqsut as a location for winter fish harvest. Subsistence users would likely avoid construction areas during construction, and resources at that location would be less available. In addition, construction would deflect subsistence resources, such as caribou and furbearers, from this important use area, reducing the availability of these resources for subsistence uses. Construction activities would decrease access by subsistence users to areas of active construction because of perceptions of regulatory barriers and safety concerns of not shooting near industrial development.

Moving the location of CD-6 outside the Northeast National Petroleum Reserve-Alaska-stipulated 3-mile sensitive area from Fish Creek and the elimination of the gravel road connecting CD-5 and CD-6 have the potential to decrease impact to subsistence uses in the Fish and Judy creeks area during the construction period in comparison to Alternative A. The construction activity would be farther from the creek and campsites, and there would be less road construction. As with Alternative A, effects from construction are expected to last 2 years in any given location and to be primarily local in extent. Alternative B differs from Alternative A principally by relocating (away from Fish Creek) or eliminating (Nigliq Channel road bridge and road from CD-2 to CD-6) some construction and infrastructure. Annual ice bridge construction and cross-tundra winter travel will be needed to reach CD-5 and CD-6. Construction would affect availability of key subsistence resources because of disturbance in the construction area and would occur in seasonal and general (i.e., areas used year round for multiple resources by the whole community) use areas for key subsistence resources that are used for more than one season each year, have been used for multiple generations, and are used for multiple resources each year. Effects from Alternative B construction would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses. Access to key subsistence-use areas would be affected because of hunter perception of regulatory barriers as well as safety concerns with shooting around development. Construction and subsequent operation of these facilities would contribute to a perception by Nuiqsut residents that they are surrounded by development. Competition for subsistence resources between communities may increase temporarily as hunters avoid usual subsistence-use areas.

OPERATION PERIOD

In contrast with Alternative A, the elimination of all-weather gravel roads between CD-2, CD-5, and CD-6 would have several effects. First, it would eliminate the road (and associated berm) as a subsistence user barrier for the approximately 15-mile distance, although a pipeline with a minimum height of 5 feet would still be located in this area. Second, with no road, air traffic in the Nigliq Channel area (CD-5) and the Fish and Judy creeks area (CD-6) would increase. At the local level, the increase in air traffic would deflect caribou, moose, and waterfowl from these important subsistence-use areas during operation of the airstrips. The annual Nigliq Channel ice bridge may delay melting of the river ice, which would temporarily reduce or alter fish habitat and delay subsistence user access to the Nigliq Channel and Harrison Bay areas in the spring. Alternative B would decrease effects to subsistence uses in the Fish Creek area because the industrial activity would be located farther from Fish Creek. However, the pipeline connecting CD-5 and CD-6 could still locally deflect caribou and moose in the Fish and Judy creeks area, reducing availability of these resources. This pipeline, like that described for Alternative A, would have a minimum elevation of 5 feet and would pose similar concerns for caribou and hunter crossing, especially with drifted snow.

In summary, Alternative B would have less of an overall effect on subsistence than Alternative A. Similar to Alternative A, industrial development in the Fish and Judy creeks and Colville River Delta areas would reduce the availability of and access to more than half of the harvest of fish, caribou, wolves, wolverines, geese, and eiders at Nuiqsut. Subsistence harvests would not be reduced to the same extent, but subsistence access would be affected as subsistence users avoid industrial areas because of perceived regulatory barriers and safety concerns of not shooting around industrial development. As noted in NRC (2003:156), “Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread.” To avoid industrial areas, hunters would hunt elsewhere and would travel farther at greater costs and effort. Currently harvest locations are based on local knowledge of resources and their abundance at traditional harvest areas. Moving to another area to avoid development means harvesters would more heavily use areas with presumably fewer and less densely distributed subsistence resources. These changes to subsistence use patterns would require increased investments in time, money, fuel, and equipment. It is likely that Nuiqsut hunters would not have the same rate of harvest success if access to these traditionally used areas is altered. These effects would last for the life of the applicant’s proposed action (30 years); in other words, for multiple hunter generations. The key resources in this area are harvested during more than one season each year, they have been used for multiple generations, and the affected areas are used for multiple resources each year. Effects of the applicant’s proposed action would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses.

ABANDONMENT AND REHABILITATION

There would be less infrastructure to remove under Alternative B than under Alternative A and that infrastructure would be farther from Fish Creek. Consequently, there would be less disruption of subsistence resources or users during the dismantlement and removal phase. Impacts following the dismantlement and removal phase would be similar to those described for Alternative A.

4B.4.3.2 Alternative B – Full Field Development Plan Impacts on Subsistence

Effects caused by the FFD scenario are analyzed in a more general way than those of the CPAI Development Plan because of the hypothetical nature of the scenario. Alternative B includes 22 locations (2 processing facilities and 20 production pads). Similar to the Alternative A FFD scenario, the Plan Area is divided into three groups: the Colville River Delta Facility Group, the Fish-Judy Creeks Facility Group, and the Kalikpik-Kogru Rivers Facility Group. The Alternative B FFD scenario is discussed in Section 2.4.

COLVILLE RIVER DELTA FACILITY GROUP

Under Alternative B, the effects of the FFD Scenario in the Colville River Delta Facility Group would be the same as under Alternative A during both construction and operation periods.

FISH-JUDY CREEKS FACILITY GROUP

The effects of this alternative for the FFD Scenario in the Fish-Judy Creeks Facility Group would be the same as those for Alternative A, with the exception that air traffic and associated subsistence effects discussed above would increase at production pads and processing facilities not connected by roads. Pads, processing facilities, and associated roads and pipelines would be located outside sensitive areas identified for no permanent oil and gas facilities in the Northeast National Petroleum Reserve-Alaska IAP/EIS, thus moving subsistence effects farther from Fish and Judy Creeks. Pipelines would cross sensitive areas where necessary. The increased number of annual ice roads would require more water withdrawal from area freshwater sources and may reduce overwintering fish habitat. These effects would have the effect of reducing the availability of multiple key subsistence resources in a primary subsistence-use area for Nuiqsut**,** though to a lesser extent than Alternative A.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Effects of development in the Kalikpik-Kogru Rivers Facility Group for Alternative B would be similar to those listed for the Alternative A FFD Scenario with a few exceptions. Elimination of one pad in an area important for caribou calving could benefit subsistence. However, an increase in air traffic in this group may deflect caribou and furbearers in an area used occasionally in summer and winter by Barrow residents, as well as occasionally by Nuiqsut residents for waterfowl and seals.

4B.4.3.3 Alternative B – Summary of Impacts (CPAI and FFD) on Subsistence

Effects from construction and operation for the Alternative B – CPAI Development Plan and Alternative B – FFD Scenario would be similar to those for Alternative A, except for the differences noted above associated with fewer roads between pads, more aircraft flights, facilities moving outside the 3-mile setback for Fish Creek, and a pipeline-only bridge across the Niqliq Channel. The overall effect on subsistence from Alternative B would be less than Alternative A.

Effects from construction and operation for the Alternative B CPAI Development Plan and FFD Scenario are expected to continue for the lifetime of the development and are expected to be primarily local in extent for the CPAI Development Plan and regional in extent for the FFD Scenario. Construction and operation would affect availability of key subsistence resources because of deflection or displacement of these resources (either by air or road traffic) from customary harvest locations. Access to subsistence resources would be affected by pipelines, especially in winter because of snowdrifts, avoidance of pads and industrial areas, the perception of regulatory barriers, the reluctance to shoot rifles in the vicinity of industrial development, the difficulty of negotiating road berms while hunting in winter, and a preference for animals not habituated to industrial development. Indirect effects would include hunters going to another area that would result in harvesting in traditional places less often and increased effort, costs, and risk associated with traveling farther. Alternative B would occur in seasonal and general use areas for key subsistence resources that are used for multiple seasons each year, have been used for multiple generations, and are used for multiple resources each year. Effects from construction and operation would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses. The construction and operation of the project would contribute to Nuiqsut residents' perception of being surrounded by development. Competition for certain resources among Nuiqsut, Anaktuvuk Pass, Barrow, and Atqasuk would increase as Nuiqsut hunters avoid traditional subsistence-use areas closer to Nuiqsut and travel to farther outlying areas.

4B.4.3.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Subsistence

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.4.3.4).

4B.4.3.5 Alternative B – Effectiveness of Protective Measures for Subsistence

The effectiveness of the protective measures would be similar to Alternative A. In addition to the protective measures in Alternative A, this alternative would adhere to Stipulation 39 of the Northeast National Petroleum Reserve-Alaska IAP/EIS and there would be no development in the Fish and Judy Creek buffer zones, an area of high subsistence use.

4B.4.4 Environmental Justice

4B.4.4.1 Introduction

The basis for identifying disproportionate impacts to minority and low-income populations is described in Section 4A.4.4.

4B.4.4.2 Alternative B – Disproportionate Impacts (CPAI and FFD) on Environmental Justice

Disproportionate impacts under Alternative B – CPAI Development Plan and Alternative B – Full-Field Development are expected to be the same as those under Alternative A for both cases (Section 4A.4.4). Changes in the location of production pads incorporated in Alternative B are not expected to change the type or level of impacts identified.

4B.4.4.3 Abandonment and Rehabilitation

Impacts will be similar to Alternative A.

4B.4.4.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Environmental Justice

Potential Mitigation Measures to reduce or avoid disproportionate impacts would be the same as those identified for Alternative A (Section 4A.4.4.3).

4B.4.4.5 Alternative B – Effectiveness of Protective Measures for Environmental Justice

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.5 Cultural Resources

4B.4.5.1 Alternative B – CPAI Development Plan Impacts on Cultural Resources

Despite the relocation of some production pads, development under this alternative would have the same impacts as Alternative A. They would have negligible direct and indirect effect on known cultural resources during construction and operation, except possibly near CD-4.

No direct or indirect effect on known cultural resources would occur from the construction and operation of the existing ASRC Mine Site or Clover. However, the use of these gravel mines would involve significant ground-disturbing activities, though less than under Alternative A, which could affect unknown surface and subsurface cultural resources.

ABANDONMENT AND REHABILITATION

It is unlikely that cultural resources would be impacted by abandonment activities.

4B.4.5.2 Alternative B – Full-Field Development Scenario Impacts on Cultural Resources

Despite the relocation of some facilities, and the elimination of others, development under this alternative would have approximately the same impacts to known cultural resources as Alternative A. Because less gravel would be used in this alternative, the risk to unknown cultural resources from gravel extraction would be reduced.

4B.4.5.3 Alternative B – Summary of Impacts (CPAI and FFD) on Cultural Resources

Impacts resulting from implementation of Alternative B are similar to those of Alternative A. Known cultural resource sites that could be affected are the same as Alternative A. Because less gravel would be needed, the risk of impacts to unknown cultural resources from extraction would be reduced.

4B.4.5.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Cultural Resources

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.4.5.4).

4B.4.5.5 Alternative B – Effectiveness of Protective Measures for Cultural Resources

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.6 Land Uses and Coastal Management

4B.4.6.1 Alternative B – CPAI Development Plan Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

Development of the Alternative B – CPAI Development Plan would affect the same landowners as described in Alternative A. Implementation of these developments would not change ownership status on lands within the ASDP Area, but would occur under negotiated leases. In addition, Kuukpik Corporation is still able to select lands, and those lands will likely be within the oil reserves. As previously stated, those lands selected are under BLM jurisdiction until patented.

The proposed development of oil production satellites and related facilities under Alternative B would result in less total area developed within the ASDP Area than under Alternative A. Development under Alternative B calls for development of approximately 204 acres, including production pads, roads, and airstrips. This would result in an increase of 2 times the total number of acres currently developed for oil production activities within the ASDP Area.

Alternative B would provide less access to the remote satellites west of Nigliq Channel than Alternative A. Access would be limited to oil industry personnel and government agencies. Effects to subsistence and recreation are discussed further in Sections 4B.4.3 and 4B.4.7. Other permitted uses within the ASDP Area, such as scientific studies, communications and navigation-related uses, and overland re-supply transport between villages, are not expected to be affected by the proposed development.

Alternative B conforms most closely to the stipulations established by the BLM for the National Petroleum Reserve-Alaska. Under Alternative B, CD-6 and all access roads and pipelines to CD-6 would be moved outside of the 3-mile buffer around Fish Creek. Other roads and bridges would be removed from water body setback areas, resulting in no direct impacts to the Fish Habitat LUEA. CD-7 would remain located within the CRSA, which was designated for maximum protection of its resources, consistent with the National Petroleum Reserve-Alaska's purpose of allowing for development of oil resources. No other Special Areas or LUEAs would be directly affected under Alternative B. In addition, there would be less total area constructed, which would minimize gravel extraction operations. There could, however, be slightly more flight activity during operations under Alternative B because of the reduced road access.

COASTAL MANAGEMENT

Development proposed under the Alternative B – CPAI Development Plan includes development both on federal lands and on state and Kuukpik lands within the coastal zone. Although federal lands are excluded from the coastal zone under the CZMA, development on federal lands is required to be consistent with state coastal programs to the extent possible. This section, therefore, evaluates the proposed development against the state and local district coastal zone standards, regardless of whether or not the development occurs on federal lands.

ALASKA COASTAL MANAGEMENT PROGRAM

The coastal standards are evaluated for Alternative B in the following sections.

Coastal Development (6 AAC 80.040)

As discussed under Alternative A, there is no feasible inland alternative to development of the existing oil resources situated within the ASDP Area. The proposed facilities have incorporated design measures to minimize potential effects to coastal resources, and development of bridges and access roads has been limited in the area closest to the coast (CD-3) and within water body setback areas. No road access across the Nigliq Channel is proposed. Stipulations on development within the National Petroleum Reserve-Alaska require that access continues to the coastal resources used for subsistence and traditional land uses; therefore, development of these facilities is not expected to displace other important coastal uses. BLM stipulations for the National Petroleum Reserve-Alaska areas also protect creek, river, and lake habitats through development setbacks. Under Alternative B, proposed facilities for the ASDP are sited outside of the Fish Creek buffer area and the other water-body setbacks. Development within the CRSA is expected to meet the requirement for maximum protection of resources through implementation of other the protective measures included in the BLM stipulations. Given its conformance with all BLM stipulations and alternative measures potentially required by the state, development under Alternative B is expected to comply with the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

Geophysical hazards are addressed under the ASDP in Alternative B just as in Alternative A, through design and siting of facilities to maintain the permafrost and natural drainage patterns and to protect the built structures from flood events, scour, ice jams, and storm surges. Incorporation of these design measures is expected to result in compliance with this standard.

Recreation (6 AAC 80.060)

Development proposed under Alternative B of the ASDP will be consistent with National Petroleum Reserve-Alaska stipulations requiring continued access to coastal resources for subsistence and other traditional land uses. The limited roads constructed within the ASDP Area would not, however, be open to recreation users, but would be limited to use by oil industry personnel. Development under Alternative B, in compliance with BLM stipulations and alternative measure potentially required by the state, is expected to comply with the recreation standard.

Energy Facilities (6 AAC 80.070)

The ASDP under Alternative B is consistent with the criteria in the energy facility standard for maximum consolidation of facilities and minimization of the potential for adverse effects to environmental resources, as discussed under Alternative A. The relocation of CD-6 out of the Fish Creek buffer area and the elimination of the Nigliq Channel crossing reduce the potential for adverse effects to below the level associated with Alternative A. Development within the CRSA would be designed to afford the maximum feasible protection to surface resources in this area. The development proposed under Alternative B, in compliance with BLM stipulations and alternative measures potentially required by the state, is expected to be in compliance with the energy facility standard.

Transportation and Utilities (6 AAC 80.080)

The development proposed under the ASDP Alternative B substantially reduces roadways compared to Alternative A. Alternative B includes a road from the existing Alpine Facility to CD-4 and a road from CD-6 to CD-7 within the Fish-Judy Creeks Facility Group. No new road access is provided to link satellite facilities west of the Nigliq Channel with the existing Alpine Facility to the east. Development under this alternative would comply with all BLM stipulations and alternative measures potentially required by the state to reduce impacts on natural and cultural resources. Thus, development of Alternative B is expected to conform to the transportation and utilities standard.

Mining and Mineral Processing (6 AAC 80.110)

Development of the ASDP under Alternative B would require approximately 204 acres of gravel pad, road, and airstrip development. The reduction of road access under this alternative reduces gravel needs and minimizes potential environmental effects associated with gravel mining. Gravel sources for this alternative would be the same as those discussed under Alternative A. As with Alternative A, development under Alternative B is expected to comply with this coastal management standard.

Subsistence (6 AAC 80.120)

The proposed ASDP under Alternative B provides road access from CD-1 to CD-4 in the Colville River Delta and from CD-6 to CD-7 in the Fish-Judy Creeks Facility Group. Access to these roads is by air or low ground pressure vehicle only, and use of these roads is restricted to oil industry personnel. Operation of the remote facilities could result in a higher level of activity in these areas than the current level, which could affect subsistence resources. The potential for adverse effects on subsistence from the proposed development is discussed in more detail in Section 4B.4.3. Development would occur under BLM stipulations and alternative measures potentially required by the state to reduce the potential for impacts on subsistence resources near proposed facilities.

Alternative B would require development within the CRSA. Development in this area is expected to maximize protection of resources through implementation of design and construction measures described in Section 2, the BLM stipulations in Appendix D, and alternative measures potentially required by the state. Development of Alternative B, in compliance with the stipulations and state measures protecting subsistence and other resources, is expected to conform with the coastal subsistence standard.

Habitats (6 AAC 80.130)

As discussed under Alternative A, the extent of wetlands, lakes, rivers, and tidal areas throughout the ASDP Area makes development within these habitats unavoidable. Development of the ASDP under Alternative B, would be in compliance with all existing BLM stipulations. Development of CD-7 within the Colville River Special Area would require maximum protection of the surface resources in that area. Since Alternative B would comply with all of the BLM stipulations, with alternative measures potentially required by the state, and with other project specific procedures identified in Section 2, it is expected to meet the standard of maximum protection. Alternative B is expected to meet the coastal habitat standard’s three-pronged test of public need, lack of feasible alternatives, and maximum conformance to coastal standards.

Air, Land, and Water Quality (6 AAC 80.140)

Development of the Alternative B – CPAI Development Plan would require the same permits and reviews discussed under Alternative A. Compliance with ADEC and USEPA regulations would result in conformance with this coastal management standard.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

Development under Alternative B would require the same process for protection of cultural resources as discussed under Alternative A. The reduced access resulting from fewer roads and more restricted access is likely to reduce the potential for inadvertent impacts to previously undocumented cultural resources. As with Alternative A, compliance with the BLM stipulations, alternative measures potentially required by the state, and the project specific procedures described in Section 2, is expected to result in conformance with this cultural resource standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

The CPAI Development Plan under Alternative B is consistent with the current NSB *Standards for Development* (NSB CMP 2.4.3) through compliance with the BLM stipulations and the coastal management standards addressed above. Potential effects to subsistence and cultural resources would be expected to be lower than for Alternative A as a result of the decreased access to the remote satellite areas under Alternative B.

The proposed plan under Alternative B complies with the current NSB *Required Features for Applicable Development* (NSB CMP 2.4.4) through compliance with the BLM stipulations and alternative measures potentially required by the state. Alternative B would result in less vehicle traffic throughout the ASDP Area, but would result in increased aircraft activity by transport personnel to the remote satellites.

Development under Alternative B would address current NSB *Best Effort Policies* (NSB CMP 2.4.5). These policies call for protection of sensitive coastal resources, including subsistence and cultural resources. Protection of these resources has been addressed in Alternative B through compliance with the BLM stipulations included in Appendix D and alternative measures potentially required by the state. Development under Alternative B is expected to be consistent with the best effort policies.

The existing NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). The proposed development under Alternative B includes design measures to protect permafrost and to address geophysical hazards as discussed above under the ACMP. Roadways and other facilities are removed from water-body setback areas and reduced through increased use of air transportation. Impacts to wildlife, vegetation and other subsistence resources are reduced through compliance with the BLM stipulations included in Appendix D and alternative measures potentially required by the state. Subsistence resources are further protected by the state of Alaska's Office of Habitat Management and Planning under Title 41 through its authority to require the proper protection of habitats important for the spawning, migration, and rearing of anadromous fish and its authority to require that durable and efficient fish passage is provided for all fish bearing water bodies. Proposed development under Alternative B is expected to be consistent with the NSB standards for minimizing negative impacts.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

As discussed under Alternative A, most of the land within the NSB is zoned as Conservation, with the exception of some village sites and the existing oilfields at Prudhoe Bay and Alpine Field. The NSB’s Resource Development zoning classification covers areas designated for oil development activities. Development east of the National Petroleum Reserve-Alaska in the Colville River Delta under Alternative B would require a rezoning of the development areas to the Resource Development classification permitting of activities through the approval of a master plan. Application of the NSB’s land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

ABANDONMENT AND REHABILITATION

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management may return to something similar to the current situation. For discussion of subsistence and recreation use after abandonment and rehabilitation, see Section 4B.4.3.1 and Section 4B.4.7.1, respectively.

4B.4.6.2 Alternative B – Full-Field Development Scenario Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

The Alternative B FFD scenario would affect the same landowners as described in Alternative A FFD. Implementation of these developments would not change ownership status on lands within the ASDP Area, but would occur under negotiated leases. In addition, Kuukpik Corporation is still able to select lands and those lands would likely be within the oil reserves. As previously stated, those lands selected are under BLM jurisdiction until patented.

The FFD scenario would result in development occurring throughout the ASDP Area, with an additional 20 production pads, 2 processing facilities, associated roads, and airstrips for a total impact area estimated at 1,056 acres and 136 miles of pipelines. The FFD scenario would result in a substantial increase in the area developed within the Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups. Although roads would connect some of the remote satellite facilities to each other, there would be no continuous road access linking development east of the Nigliq Channel at the existing Alpine Facility to areas west of the channel. Access to areas west of the channel would require air transport, and access would remain limited to oil industry personnel. Although there would be increased activity levels in these areas resulting from operation of the facilities, the activity level would be lower than that under Alternative A. Effects on subsistence resources and recreation for FFD are discussed in Section 4B.4.3 and Section 4B.4.7.

Full-field development under Alternative B would more closely conform to the BLM stipulations for National Petroleum Reserve-Alaska in that production satellites would be placed outside of buffer areas and areas where surface activities are restricted. Some development would occur within the CRSA and would be required to provide maximum protection of surface resources. Flights could increase for this scenario, as compared to Alternative A, because of the increased number of satellite facilities accessible only by air.

COASTAL MANAGEMENT

Development proposed under the Alternative B – Full-Field Development Scenario includes development on mostly federal lands inside National Petroleum Reserve-Alaska and on state and Kuukpik lands within the coastal zone. Although federal lands are excluded from the coastal zone under the CZMA, development on federal lands is required to comply with state coastal management programs to the extent feasible. Therefore, this section evaluates the proposed development against the state and local coastal zone standards, regardless of whether or not the development occurs on federal lands.

ALASKA COASTAL MANAGEMENT PROGRAM

The coastal standards are evaluated for Alternative B in the following sections:

Coastal Development (6 AAC 80.040)

Full-field development under Alternative B differs from Alternative A in the elimination of a production satellite near the Kogru River, the elimination of a road bridge across the Nigliq Channel, and situating other production and processing facilities outside water body setback areas. Roads are proposed to connect some production satellites to regional oil processing facilities. Access to satellites in the Colville River Delta would occur only by air, ice road or low ground pressure vehicle. Development of these facilities would incorporate BLM stipulations and alternative measures potentially required by the state to minimize potential effects to coastal resources. Thus, the Alternative B – Full-Field Development Scenario is expected to conform to the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

Development of facilities under FFD would be required to meet the same design standards to protect permafrost and to reduce the potential for damage to structures or personnel from floods and other severe weather events. As with Alternative A, incorporation of these design measures is expected to result in conformance with this standard.

Recreation (6 AAC 80.060)

Development of facilities under FFD would be required to comply with the same stipulations on continued access for subsistence and traditional land uses within the National Petroleum Reserve-Alaska. Again, facilities constructed under this alternative would not provide any new access for recreation because they would be restricted to oil industry personnel. Development of the Alternative B – Full-Field Development Scenario, with the stipulations included in Appendix D and alternative measures potentially required by the state, is expected to conform to the recreation standard.

Energy Facilities (6 AAC 80.070)

The Alternative B – Full-Field Development Scenario would result in a lower potential for environmental impacts because of reduced road construction and moving facilities out of creek buffers and other water body setbacks. Thus, FFD under Alternative B would be expected to comply with the criteria of the energy facility standard.

Transportation and Utilities (6 AAC 80.080)

Full-field development calls for additional satellite development throughout the Plan Area. Roads are proposed to connect remote satellites with regional processing facilities in the Kalikpik-Kogru Rivers and Fish-Judy Creeks facility groups. No road access is provided between the remote facilities and the existing Alpine Facility. Development of Alternative B is expected to comply with the coastal standards for transportation and utilities.

Mining and Mineral Processing (6 AAC 80.110)

The Alternative B – Full-Field Development Scenario would require less gravel than FFD under Alternative A. Full-field development would still likely require resources beyond those currently identified. Any new gravel mining operation within the coastal zone would be required to receive a permit, which would maximize compliance with state coastal management standards and protection of coastal resources. As with Alternative A, FFD under Alternative B would be expected to comply with the coastal mining standard.

Subsistence (6 AAC 80.120)

Full-field development would result in more widespread development of satellite facilities. Roads are proposed to connect some remote satellites to each other and to regional processing facilities, but no direct road access is provided to link the remote satellites to the existing Alpine Development Project on the east side of Nigliq Channel. Access on industry roads would be restricted to industry personnel only. Operation of the remote satellites would result in some additional activity in remote areas, which could affect subsistence resources to some degree. Potential effects on subsistence from development under FFD are discussed further in Section 4B.4.3. Construction and operation of these facilities would be required to comply with the BLM stipulations outlined in Appendix D, and alternative measures potentially required by the state to minimize effects to subsistence to the greatest extent possible. Development under Alternative B, in compliance with the stipulations listed in Appendix D and alternative measures potentially required by the state, is expected to comply with the subsistence standard.

Habitats (6 AAC 80.130)

Full-field development would result in additional impacts to coastal habitats. Impacts would be lower than those discussed under Alternative A – Full-Field Development Scenario in that Alternative B removes production, processing, and roadway facilities from water body setbacks and restricted areas near the Kogru River. FFD under Alternative B also eliminates the road and bridge construction across the Nigliq Channel and limits access to remote sites to oil industry personnel. Development under Alternative B, in compliance with the stipulations listed in Appendix D, and alternative measures potentially required by the state, is expected to comply with the coastal management habitat standard.

Air, Land, and Water Quality (6 AAC 80.140)

Development of the FFD scenario under Alternative B would require the same permits and reviews discussed under Alternative A. Compliance with ADEC and USEPA regulations would result in conformance with this coastal management standard for the FFD scenario.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

The Alternative B – Full-Field Development Scenario would require the same process for protection of cultural resources as discussed under Alternative A. The reduced access resulting from fewer roads and more restricted access is likely to reduce the potential for inadvertent impacts to previously undocumented cultural resources. The Alternative B – Full-Field Development Scenario, developed in compliance with the stipulations and alternative measures potentially required by the state, is expected to be in conformance with this standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

The Alternative B – Full-Field Development Scenario is consistent with the current NSB *Standards for Development* (NSB CMP 2.4.3) through compliance with the BLM stipulations and the coastal management standards addressed previously in this section. Potential effects to subsistence and cultural resources would be expected to be lower than FFD under Alternative s a result of the decreased access to the remote satellite areas.

Full-field development under Alternative B complies with the current NSB *Required Features for Applicable Development* (NSB CMP 2.4.4) through compliance with the BLM stipulations, alternative measures potentially required by the state, and project specific procedures described in Section 2. The Alternative B – Full-Field Development Scenario would result in less vehicle traffic throughout the Plan Area, but would result in increased aircraft activity to transport personnel to the remote satellites.

The Alternative B – Full-Field Development Scenario would address current NSB *Best Effort Policies* (NSB CMP 2.4.5). These policies call for protection of sensitive coastal resources including subsistence and cultural resources. These issues have been addressed above in the ACMP discussion. Again, Alternative B would be expected to reduce potential effects because of more restricted access to the remote satellites. Development of FFD under Alternative B, consistent with the project specific procedures in Section 2, the BLM stipulations, and alternative measures potentially required by the state, is expected to consistent with the NSB best effort policies.

The existing NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). The proposed Alternative B FFD includes measures designed to protect permafrost and to address geophysical hazards as discussed above under the ACMP. Roadways and other facilities would be removed from water body setback areas and reduced through increased use of air transportation. Other adverse effects to wildlife, habitats, and subsistence are reduced through the project specific procedures in Section 2, the BLM stipulations in Appendix D, and alternative measures potentially required by the state. Therefore, the proposed FFD under Alternative B is expected to be consistent with the NSB standards on minimizing negative impacts.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

Development to the east of National Petroleum Reserve-Alaska in the Colville River Delta under Alternative B FFD would require a re-zoning of the development areas to the "Resource Development" classification and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4B.4.6.3 Alternative B – Summary of Impacts (CPAI and FFD) on Land Uses and Coastal Management

Construction and operation of Alternative B – CPAI Development Plan is not anticipated to result in adverse effects to existing land uses and ownership. A direct impact, however, would be the increase in the acres of developed land. Implementation of the Alternative B – CPAI Development Plan would result in an increase of 2 times the total number of acres developed for oil production within the ASDP Area. Unlike Alternative A, all facilities and construction would occur outside the Fish Creek buffer area, thus eliminating the need for an exception to the stipulation restricting development activities within this area. Full-field development would place structures outside of buffer areas and areas where surface activities are restricted. Some development would occur in the CRSA, which is designated for maximum protection of surface resources consistent with the purpose of the area, which is to develop oil reserves. Conformance with the project specific procedures in Section 2, the BLM stipulations in Appendix D, and alternative measures potentially required by the state, is expected to meet the maximum protection criterion.

The proposed development under Alternative B, constructed and operated in compliance with the project specific procedures in Section 2, the BLM stipulations, and alternative measures potentially required by the state, is expected to be consistent with state and NSB coastal management policies. Implementation of the CPAI proposal and/or FFD would require NSB re-zoning of plan areas east of the National Petroleum Reserve-Alaska from "Conservation" to "Resource Development" and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4B.4.6.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Land Uses and Coastal Management

No mitigation measures have been identified for the Alternative B CPAI or FFD Scenarios.

4B.4.6.5 Alternative B – Effectiveness of Protective Measures for Land Uses and Coastal Management

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.7 Recreation Resources

4B.4.7.1 Alternative B – CPAI Development Plan Impacts on Recreation Resources

Under this alternative, effects on recreation users in the plan area would be similar for those described for Alternative A**.** The Alternative B – CPAI Development Plan to develop five pads could potentially affect the recreation experience, including those values mentioned for Alternative A (solitude, quietude, naturalness, and wilderness) over approximately 40,000 acres. However, the recreational use of the Plan Area is very low, and most recreation occurs directly along the Colville River corridor where activities associated with Nuiqsut already have decreased some of these recreational values. Therefore, actual effects to the recreational experience would be minor. Impacts may be lessened compared to those of Alternative A because of the reduced road activity (no roads) associated with development across the Nigliq Channel, though this may be offset by a resultant increase in aircraft traffic. As with Alternative A, recreational opportunities in the Plan

Area under this alternative would remain consistent with the BLM's SPM classification. As a result, no mitigation measures have been identified for this alternative.

ABANDONMENT AND REHABILITATION

Impacts from abandonment and rehabilitation would be somewhat less on recreational use under this alternative than Alternative A. Most recreational use near components of the Alternative B – CPAI Development Plan is along the Nigliq Channel. There would be fewer disturbances along the Nigliq Channel from abandonment and rehabilitation activities because less infrastructure would have been built there. Also because there is no road near the Nigliq Channel, there would be less opportunity for enhanced access after abandonment.

4B.4.7.2 Alternative B – Full-Field Development Scenario Impacts on Recreation Resources

Under the FFD alternative, the types of effects on hunting, fishing, and birding opportunities and the qualities of solitude, quietude, naturalness, and wilderness would be the same as those described for the Alternative B – CPAI Development Plan. However, the potential for such effects would increase under FFD as a result of the increased geographic scope of development. In addition to the potential effects on approximately 40,000 acres from the CPAI scenario, the recreational opportunities on as many as 176,000 acres could be affected if as many as the 22 proposed processing or production pads were developed. The level of impacts for FFD would be similar to that under FFD for Alternative A.

4B.4.7.3 Alternative B – Summary of Impacts (CPAI and FFD) on Recreation Resources

Construction and operation of the facilities proposed under Alternative B (CPAI and FFD) in the Plan Area are not expected to result in more than local adverse effects to the lightly used recreational resources of the Plan Area.

4B.4.7.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Recreation Resources

No mitigation measures have been identified.

4B.4.7.5 Alternative B – Effectiveness of Protective Measures for Recreation Resources

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.8 Visual Resources

4B.4.8.1 Alternative B – CPAI Development Plan Impacts on Visual Resources

CONSTRUCTION PERIOD

Construction impacts would be roughly the same as those described in Alternative A.

OPERATION PERIOD

Alternative B would introduce moderate contrast through operation of the five production pads. Some impacts would be lessened. Burial of the power line would eliminate the visual impacts of power poles, and fewer roads would reduce visual impacts of those structures and traffic. Moving CD-6 more than a mile farther from Fish Creek would slightly reduce its visibility and produce less contrast to viewers along the creek. Two additional airstrips (at CD-5 and CD-6) would introduce additional contrast with the natural landscape. If viewed from very close distances within the foreground and middle-ground zone, the color and texture of the airstrips would produce a moderate contrast with the natural landscape. However, since roads would be either non-existent or not accessible to local residents near the airstrips, this would be a negligible impact.

ABANDONMENT AND REHABILITATION

The impacts of abandonment and rehabilitation would be similar to those for Alternative A, though there would be less short-term visual impacts created by fugitive dust.

4B.4.8.2 Alternative B – Full-Field Development Scenario Impacts on Visual Resources

Full-field development construction and operation would introduce moderate contrast. These impacts may be slightly reduced from that described for FFD under Alternative A because there would be fewer and less use of roads and because some pads and their associated roads and pipelines would be moved farther from water travel routes, including Fish and Judy creeks.

4B.4.8.3 Alternative B – Summary of Impacts (CPAI and FFD) on Visual Resources

Alternative B would result in adverse impacts to visual resources, however this alternative would have slightly less of an impact than Alternative A because all power lines would be buried, and as a result, power poles would not be needed, and because some other facilities, including CD-6 in the applicant’s proposed action, would be moved away from some water travel routes.

4B.4.8.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Visual Resources

Potential mitigation measures would the same as those identified for Alternative A (Section 4A.4.8.5).

4B.4.8.5 Alternative B – Effectiveness of Protective Measures for Visual Resources

The effectiveness of the protective measures would be similar to Alternative A.

4B.4.9 Transportation

4B.4.9.1 Alternative B – CPAI Development Project on Transportation

ROADWAYS

Alternative B would result in the construction of 3 airstrips (at CD-3, CD-5, and CD-6), 10 miles of new gravel roads, and 36.5 miles of pipelines within the Plan Area. Use of the roadways and airstrip would be restricted to oil industry personnel and would not be open to residents of Nuiqsut.

This alternative significantly reduces the roadway network west of the Nigliq Channel and relies instead on air access, ice roads, and low ground pressure vehicles to most of the proposed production pads.

CONSTRUCTION PERIOD

Construction activities, phasing, and workforce under Alternative B would be the same as under Alternative A. No adverse effects on any public roadways are anticipated.

OPERATION PERIOD

Operation of the ASDP facilities would result in an increase of supply shipments to the North Slope on the Dalton Highway, as discussed under Alternative A. This increase is not expected to adversely affect traffic operations on the Dalton Highway or industry roads to the east of the Alpine Facility. Operation of the facilities under Alternative B would result in a lower level of traffic within the Plan Area than under Alternative A. Road access within the Plan Area would only be available from the Alpine Facility to CD-4 and from CD-6 to CD-7. Transport of bulk operating supplies and materials to the production pads would only be possible during the winter, resulting in a need to construct larger storage facilities at the production pads. High-value, low-weight supplies, or other essential supplies that cannot wait to be sent until winter, may be shipped in by air.

Alternative B limits use of those gravel roads constructed within the Plan Area to industry-related personnel only. The only section of road west of the Nigliq Channel is between CD-6 and CD-7, and access to that section of road could only be by airstrip at CD-6, ice road, or low-ground-pressure vehicle. Therefore, Alternative B does not provide any new year-round road access to areas west of the Nigliq Channel in the Fish-Judy Creeks Facility Group. This design would result in much of the supply operations related to the site being concentrated in the winter, which would reduce total summer activity in the area. Potential effects to subsistence resources from this increased activity are addressed under Section 4B.4.3.

RAILROAD TRANSPORTATION

CONSTRUCTION PERIOD

As discussed under Alternative A, this alternative would not adversely affect rail transportation facilities during construction.

OPERATIONS PERIOD

As under Alternative A, this alternative would not adversely affect rail transportation facilities during operations.

MARINE FACILITIES

CONSTRUCTION PERIOD

As under Alternative A, Alaska ports and marine transport firms are expected to have sufficient capacity to meet any demands for marine transport associated with construction. This alternative is not expected to adversely affect marine transportation facilities.

OPERATIONS PERIOD

Transport of supplies during normal operations does not typically involve marine transport. Therefore, operation of the facilities proposed under Alternative B would not adversely affect marine transportation facilities.

RIVER TRANSPORTATION

CONSTRUCTION PERIOD

Most construction in the vicinity of rivers would occur during winter. Under Alternative B, there would be more use of ice roads and ice bridges throughout the construction period. Construction activities may interfere with some winter travel on frozen channels, but the interference is expected to be limited and it is expected that local residents' travel needs will be accommodated through construction areas. The increased use of ice bridges could potentially temporarily affect river access early in the summer if the ice bridge were to delay ice breakup in the river.

OPERATIONS PERIOD

Alternative B proposes construction of only pipelines over most waterways, including the Nigliq Channel and the Ublutuoch River. Pipeline bridges on navigable waterways would be designed to minimize effects on navigation. The lack of gravel roads would require more use of ice bridges throughout the operations period, increasing the potential for delayed access to river channels. The docks proposed under this alternative are the same as those proposed under Alternative A. Therefore, operation of the facilities proposed under Alternative B is not expected to have any adverse effects on river transportation.

AVIATION FACILITIES

CONSTRUCTION PERIOD

As discussed under Alternative A, most construction personnel are expected to be transported by air to the North Slope by Shared Services Aviation. The construction workforce for Alternative B is similar to that discussed in Alternative A and effects would be similar. Because of the absence of gravel roads, however, air traffic levels are anticipated to be higher for Alternative B than for Alternative A. Transport of these additional workers and supplies would not be expected to have an adverse effect on aviation facilities and services to the North Slope.

Construction operations for the proposed facilities under Alternative B could result in slightly more aircraft flights (five per day) during construction, particularly during summer work on production pads. Because most construction would take place in the winter, however, the increase in flights could be minimal. It is expected that Shared Services Aviation would be able to provide the additional flights required and contract support could be used to supplement these flights.

OPERATIONS PERIOD

The demand for aviation support for operation of the production pads under Alternative B would require additional flights to the three west production pads because no road access from the housing facilities at the Alpine Facility would be available. It is estimated that operations personnel would fly from the existing Alpine Facility to these remote sites once every 3 days. It is expected that Shared Services Aviation would be able to accommodate these additional trips with its existing crews and air fleet. These services may be supplemented with contract air support as needed. The increased demand for air support is not expected to adversely affect air transportation resources within the region; however, it would have a direct impact on noise levels in the vicinity of the applicant’s proposed action.

PIPELINES

CONSTRUCTION PERIOD

There would be no effects on existing pipeline facilities during the construction phase**.**

OPERATIONS PERIOD

During operations, production flows would be managed to remain within the capacity of the existing sales oil pipeline from the Alpine Facility to Kuparuk. As under Alternative A, the projected increase in throughput to TAPS under Alternative B is expected to remain well within the capacity of the pipeline.

ABANDONMENT AND REHABILITATION

Impacts would be similar to those associated with Alternative A.

4B.4.9.2 Alternative B – Full-Field Development Scenario on Transportation

ROADWAYS

Construction impacts to roadways outside the Plan Area would be similar to those identified for Alternative A. Construction materials and personnel from Kuparuk would be transported to the Plan Area primarily by ice road in the winter. Some high-value, low-weight materials could be flown in to remote construction sites once the airstrips have been built.

Operations vehicular traffic associated with FFD would be lower under Alternative B than under Alternative A. Although no bridge over the Nigliq Channel to connect the western production pad areas to the existing Alpine Facility is proposed, the roadway network would connect the production pads in the eastern portion of the Fish-Judy Creeks Facility Group. This road network would not directly connect to Nuiqsut, but would be near the village. The more remote roadway networks connecting the production pads in the central and western portions of the Fish-Judy Creeks Facility Group and the roadways in the Kalikpik-Kogru Rivers Facility Group would not be connected across the Nigliq Channel to the existing Alpine Facility or other industry road networks to the east. No public access would be allowed on the proposed roads; use would be restricted to personnel related to the oil industry activities.

RAILROAD TRANSPORTATION

The demands on the railroad for construction and operation of the FFD Scenario would be the same for Alternative B as for Alternative A. It is expected that Alaska Railroad could meet the construction and operation needs without adversely affecting ongoing railroad operations.

MARINE FACILITIES

Phased construction of the FFD Scenario would likely occur over many years. Marine transport would likely be used to transport large, heavy construction equipment or production facilities for use in the Plan Area. Although the demand for marine transport has not been quantified, it is assumed that existing marine support services could accommodate the construction and operations demand associated with the FFD Scenario.

RIVER TRANSPORTATION

Construction and operations activities under Alternative B are likely to be similar to those described under Alternative A. Although Alternative B has more pipeline bridges and less road bridges, the impacts would be expected to be similar. There could be a need for more ongoing use of ice bridges across the Nigliq Channel, which could result in delaying access to the channel in the summer.

AVIATION FACILITIES

The Alternative B – Full-Field Development Scenario would require additional air support during construction and operations, especially for construction of the remote production pads. Transport of personnel from Anchorage or Fairbanks to Deadhorse, Kuparuk, or both would remain the same as for Alternative A. Air traffic, however, is anticipated to be somewhat higher than for Alternative A. There could be substantial increased demand (by as much as 40 percent) for flights from Kuparuk or the Alpine Facility to the proposed construction sites throughout the Plan Area, particularly during summer months, because of the lack of road access. Because development of the remote facilities under FFD is likely to be phased over a substantial period of time, it is believed that this level of flight operations could be accommodated by Shared Services Aviation and be supplemented with contract aviation support as needed. This additional demand is not expected to adversely affect air transportation resources in the region.

Operations under FFD would require that personnel fly to remote production pads approximately 3 times per weeks. Because of the number of production pads that have no road access, the demand for aviation support for these remote facilities would increase the number of flights needed. It is possible that there would be a need for Shared Services Aviation to increase its capacity or to be supplemented with contract aviation support. This additional demand is not expected to adversely affect air transportation resources in the region.

PIPELINES

As with Alternative A, the volume of oil to be produced from the phased implementation of FFD would be expected to remain within the capacity of the sales oil pipeline from the Alpine Field and TAPS.

4B.4.9.3 Alternative B – Summary of Impacts (CPAI and FFD) on Transportation

Most bridge construction activities will be conducted when the impacted waterways are frozen. If not, the applicant should work with local village and other vessel operators in order to facilitate marine navigation during construction. If bridge construction activities requires limiting vessel traffic, the applicant should issue sufficient notification of such closures to reduce conflict with marine navigation activities. A condition of the applicant's Coast Guard Bridge permit will require that construction of falsework, cofferdams or other obstructions, if required, shall be in accordance with plans submitted to approved by the Commandant prior to construction of the bridges. All work shall be so conducted that the free navigation of the waterway is not unreasonably interfered with and the present navigational depths are not impaired. Timely notice of any and all events that may affect navigation shall be given to the District Commander (Seventeenth District) during construction of the bridges.

4B.4.9.4 Alternative B – Potential Mitigation Measures (CPAI and FFD) for Transportation

The potential for impacts to river navigation during construction could be mitigated through development of a navigation plan for commonly navigated channels that would be crossed by pipelines or bridges. The navigation plan should be submitted to the USCG for review prior to the start of construction of pipelines or bridges over commonly navigated channels. This could help minimize impacts to river navaigation and help assure reasonable navigation means during construction.

4B.4.9.5 Alternative B – Effectiveness of Protective Measures for Transportation

The effectiveness of the protective measures would be similar to Alternative A.