Final Environmental Impact Statement
Pogo Gold Mine Project

Delta, Alaska

National Pollutant Discharge Elimination System (NPDES) Permit Application No. AK-005334-1

September 2003

Prepared By:

U.S. Environmental Protection Agency
Region 10
Office of Water, NPDES Permits Unit

Cooperating Agencies:

U.S. Army Corps of Engineers

Alaska Department of Natural Resources

With Assistance From:

Baker
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Michael Baker Jr., Inc.

Volume I

Final

Pogo Gold Mine
Environmental Impact Statement

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Executive Summary

Introduction

The Applicant, Teck-Pogo Inc., has applied to the U.S. Environmental Protection Agency (EPA) for a National Pollutant Discharge Elimination System (NPDES) permit to discharge waste waters from the Pogo mine project to the Goodpaster River (see list of acronyms at end of summary). Because the proposed project has the potential to significantly affect the quality of the human environment, the decision on issuance of the NPDES permit is considered a "major federal action." The National Environmental Policy Act (NEPA) (Title 40, U.S. Code of Federal Regulations [CFR], Parts 1500-1508) requires preparation of an environmental impact statement (EIS) for all major federal actions. This Executive Summary presents a synopsis of the final EIS (FEIS). The FEIS itself, as well as additional information about the Pogo Mine EIS process, including baseline reports and technical documents, can be found on the Web at http://www.pogomineeis.com. A compact disk (CD) or a bound paper copy of the FEIS may be obtained by contacting:

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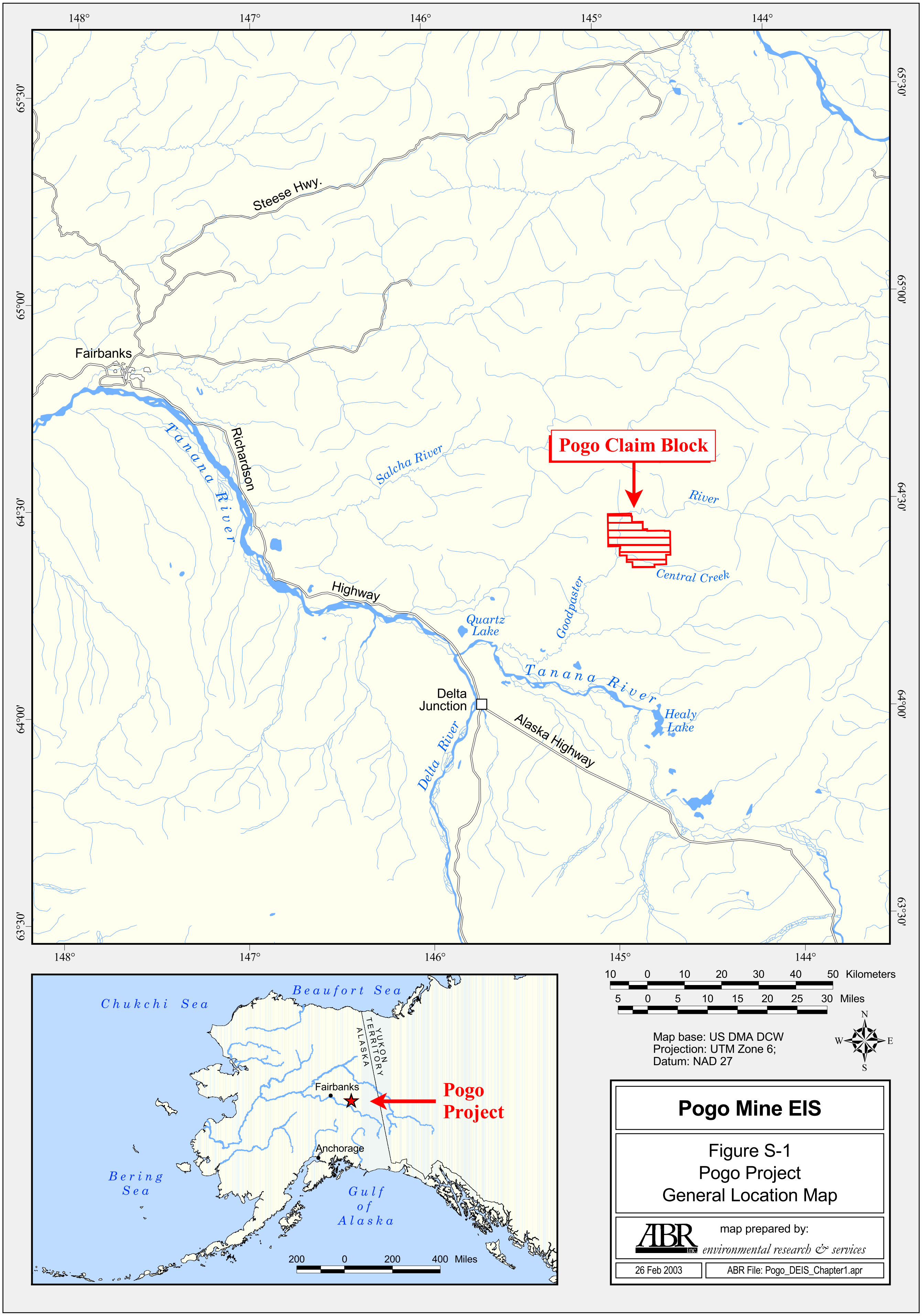
S.1 Summary of Proposed Action

The proposed action is a plan by the Applicant to develop the underground Pogo Mine on State of Alaska land in the Goodpaster River Valley approximately 38 miles northeast of Delta Junction, in east-central Alaska (Figure S-1). The project would require 25 to 33 months to construct and would have an operating life of approximately 11 years, based on current ore reserves. Its life could be extended if additional reserves were found. The capital cost of the project is estimated at $200 million to $250 million. The mine would operate 365 days a year with an initial workforce of approximately 288. The proposed action would include a mill and camp complex, a dry-stack tailings pile and recycle (water) tailings pond (RTP), an airstrip, gravel pits, laydown and fuel storage areas, and a local network of roads. Gold would be recovered by gravity separation, flotation concentration, and cyanide vat leaching. Approximately half of the tailings would be returned underground as a paste backfill. Surface access to the mine would be provided by an all-season 49.5-mile road. Power would be supplied from the regional grid through a 50-mile power line.



Pogo Mine EIS

Figure S-1
Pogo Project
General Location Map

S.2 Purpose and Need for Action

Need for Action

The need for the proposed action is to allow Teck-Pogo Inc. to develop an underground mine in its nonfederally owned Pogo claim block in order to produce gold and to make a reasonable profit.

Purpose for Action

The purpose of the proposed action is to provide the federal authorizations needed for Teck-Pogo Inc. to construct and operate an underground gold mine and associated facilities in and near its Pogo claim block, which is located in a currently roadless area 38 miles northeast of Delta Junction, Alaska, near the Goodpaster River. The mine would process between 2,500 and 3,500 tons per day of ore for at least 11 years to supply an on-site mill, which would produce up to approximately 500,000 ounces of gold per year through gravity recovery, froth flotation, and cyanide leaching of concentrate. The proposed action would meet the objectives for construction and operation of the mine by providing:

- An efficient, on-site mill and gold extraction process
- Safe, stable, long-term disposition of 11 million tons of tailings with sufficient capacity to contain potential additional ore reserves
- An adequate water supply to meet mill process and camp complex requirements, and safe discharge of water
- 10 to 14 megawatts of electrical energy needed to construct and operate the mine and mill
- A comfortable on-site camp complex capable of supporting 250 to 700 personnel needed to construct and operate the mine and mill
- Reliable and safe access to the mine for delivery of materials, including approximately 2 million to 3 million gallons of fuel and 25,000 to 38,000 tons of nonfuel supplies per year, and the 250 to 700 personnel needed to construct and operate the mine and mill on a cost-efficient basis
- Timely project development
- Development of the project in a technically and economically feasible manner

S.3 Agency Involvement

EPA has assumed lead federal agency responsibility for preparation of the EIS. In order to construct and operate the mine, many other federal and state permits are needed, and the U.S. Army Corps of Engineers (COE) and State of Alaska Department of Natural Resources (ADNR) have participated as cooperating agencies for the EIS.

S.4 Scoping

EPA provided for an early and open scoping process to determine the scope of issues to be addressed and to identify the significant issues related to the Pogo Mine project. On August 11, 2000, EPA published a Notice of Intent to prepare an EIS for the Pogo Mine project in the Federal Register. Simultaneously, EPA distributed the Scoping Document for the Pogo Mine Project Environmental Impact Statement that described the proposed project, the EIS process, and a document preparation schedule. Distribution of the scoping document began a 60-day public and agency review and comment period that ended on October 10, 2000. EPA hosted two scoping open houses during that period in Delta Junction and Fairbanks.

Scoping identified 17 major issues related to construction, operation, and closure of the proposed project. These issues served as the basis for development of criteria that were used to evaluate impacts of the various project options and alternatives. On January 30, 2001, EPA distributed a 55-page Pogo Mine EIS Scoping Responsiveness Summary that described the scoping process, identification of issues, evaluation criteria, the option screening process, and how alternatives were developed.

S.5 Government-to-Government Consultations

In addition to the EIS scoping effort, pursuant to Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments), EPA undertook a concerted government-to-government consultation effort with the 13 Tribes considered to be potentially affected by the proposed Pogo Gold Mine by virtue of their location (1) within a 125-mile radius of the proposed Pogo Mine site, or (2) within the potentially affected Tanana River watershed.

S.6 Issues and Options Identification and Screening

For the following discussion, it is important that the reader understand the relationship between the terms "component," "option," and "alternative."

- Component. A complete mining project such as the Pogo Mine has several components, each a necessary part of an entire viable project; for example, the mill process, the tailings disposal system, and how the project location is accessed.
- Option. For each component, there are one or more options, or choices; for example, for the access component there are all-season road options (Shaw Creek Hillside and South Ridge) and winter road/trail options (Shaw Creek Flats and the Goodpaster Valley).
- Alternative. An alternative is a set of options (one for each component) that constitutes an entire functioning project; for example, one mill process, one tailings disposal location, one airstrip location, and one surface access route.

As a result of the public scoping process and agency input, 17 issues were identified to be addressed during the EIS process.

- Surface and groundwater quality
- Wetlands
- Fish and Aquatic habitat
- Wildlife
- Air quality
- Noise
- Safety
- Reclamation
- New industrial and commercial users
- Recreational resources and users
- Existing privately owned lands and existing recreational and commercial uses
- Subsistence and traditional uses
- Cultural resources
- Socioeconomics
- Cumulative impacts
- Technical feasibility
- Economic feasibility

Then, options and sub-options for each project component were developed, other than those proposed by the Applicant, that could address each of these issues. Because all the options and sub-options considered, including those proposed by the Applicant, totaled more than 100, it was necessary to reduce them to a more manageable number that still provided a reasonable range from which to identify full project alternatives. Thus, for each issue, a set of evaluation criteria was developed. These criteria were used to screen each of the options to determine those best able to address the issues and to be retained for detailed impacts analysis, and those to be dropped from further consideration. The options and sub-options retained for detailed analysis then were grouped into three action alternatives. Each action alternative contains a full set of options that would constitute a complete mining project.

S.7 Identification of Alternatives

NEPA requires that an EIS consider alternatives to the proposed action that address issues identified during the scoping process. To present these options and sub-options as part of the three action alternatives in the most understandable manner, they were divided into the following three groups of components, which are presented, respectively, in Tables S-1, S-2, and S-3. The alternatives are described in the following section (S.8).

1. Options and sub-options that are common to all three action alternatives
2. Options and sub-options that vary between the alternatives, but that *are not* related to surface access
3. Options and sub-options that vary between the alternatives, and that *are* related to surface access

S.8 Alternatives Description

Descriptions of the No Action Alternative and the three action alternatives are found below. Figure S-2 presents the options for each alternative that differ between the alternatives. Note that Figure S-2 does not contain those options that would be common to all alternatives (Table S-1) because, by definition, there would be no difference in impacts between the alternatives. These common option impacts, however, are presented with the impacts of all other options later in under environmental consequences.

Table S-1 Component Options and Sub-Options Common to All Action Alternatives

Milling Process
- Gravity / flotation / cyanide vat leach[1]

Tailings Disposal
- Underground paste backfill
- Surface dry stack and RTP in Liese Creek Valley

Mill and Camp Location
- Liese Creek Valley

Development Rock Disposal
- Mineralized rock encapsulated in dry stack
- Nonmineralized rock into dry stack, and for RTP dam and other construction

Gravel Source
- Expand existing pits; develop new pits in Goodpaster and Liese Creek valleys
- Crush nonmineralized development rock

Construction Camp
- At existing exploration camp below 1525 Portal in Goodpaster Valley

Laydown Area
- Permanent below existing 1525 Portal, adjacent to airstrip, and at mill

Water Supply

Industrial
- Mine drainage
- RTP
- Wells

Domestic
- Wells

Water Discharge

Operations Phase
- Domestic wastewater
  - Package treatment plant and direct discharge to Goodpaster River

Fuel Storage Location
- Temporary below 1525 Portal and airstrip; permanent at portal mouth and mill

Air Access
- 3,000-foot airstrip in Goodpaster Valley
- Use of road during mine operations
  - Pogo project only
  - Pogo and other industrial / commercial users only
  - Everyone
- Disposition of airstrip at end of Pogo project
  - Remove and reclaim following mine reclamation
  - Open for Industrial / commercial resource users only
  - Open for everyone

[1] Underline – Applicant's proposed option or sub-option

ALTERNATIVES ANALYZED IN THIS EIS

AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1]	COMPONENTS NOT SURFACE ACCESS RELATED				COMPONENTS SURFACE ACCESS RELATED				
			WATER DISCHARGE		ACCESS				
=	TAILINGS FACILITY LINER +	POWER SUPPLY +	DEVELOPMENT PHASE +	OPERATIONS PHASE +	TYPE +	ROUTE +	USE +	DISPOSITION +	POWER LINE ROUTE
	Options	Options	Options	Options	Options	Options	Options	Options	Options
ALTERNATIVE 1 NO ACTION	Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented.								
ALTERNATIVE 2 Applicant's Proposed Project	Unlined	Power Line	Injection Wells	▪ Injection Wells, and ▪ SAS ◆ At airstrip ◆ Above Pogo Ridge	All-Season Road	▪ Shaw Creek Hillside, Richardson Egress ◆ Shaw Creek Road ◆ Tenderfoot	▪ Pogo Project Only, or ▪ Pogo and: ◆ Industrial/ Commercial ◆ Everyone	▪ Remove/Reclaim, or ▪ Road Left Open to: ◆ Industrial/ Commercial ◆ Everyone	Shaw Creek Hillside
ALTERNATIVE 3 South Ridge Route Direct Discharge	Lined	"	Direct Discharge to Goodpaster River	Direct Discharge to Goodpaster River	"	South Ridge	"	"	South Ridge
ALTERNATIVE 4 Winter Only Access Off-River Treatment Works	"	On-Site Generation	Off-River Treatment Works	Off-River Treatment Works	Winter Access Only ▪ Traditional Road ▪ Perennial Trail	Shaw Creek Flats	N/A[2]	N/A	N/A
Major Options Eliminated From Further Consideration[3]			Constructed Wetlands		Railroad Air Only (5,000-ft Airstrip)	Richardson Egress: ▪ Pipeline ▪ Keystone Dean Cummings Crossing Goodpaster Valley		Convert to Recreational Trail	

[1] Excludes those components/options common to all alternatives (Table 2.5-1).
[2] Not applicable to this alternative.
[3] See Appendix A.1.

Figure S-2

Table S-2 Component Options and Sub-Options that are Specific to Certain Action Alternatives, but Not Related to Surface Access

Component / Option / Sub-Option	Alternative 2	Alternative 3	Alternative 4
Tailings Facility Liner			
▶ Surface dry stack and RTP in Liese Creek			
✦ Lined dry stack		X	X
✦ Lined RTP		X	X
✦ Unlined dry stack[1]	X		
✦ Unlined RTP	X		
Power Supply			
▶ Power line	X	X	
▶ On-site generation			X
Water Discharge			
Development Phase			
▶ Industrial wastewater			
✦ Underground injection wells	X		
✦ Direct discharge to Goodpaster River		X	
✦ Off-river treatment works			X
Operations Phase			
▶ Industrial wastewater			
✦ Soil absorption system (SAS)			
⏩ Goodpaster River Valley adjacent to airstrip	X		
⏩ Saddle above and southeast of Pogo Ridge	X		
✦ Underground injection wells	X		
✦ Direct discharge to Goodpaster River		X	
✦ Off-river treatment works			X

[1] Underline – Applicant's proposed option or sub-option

Table S-3 Component Options and Sub-Options that are Related to Surface Access

Component / Option / Sub-Option	Alternative		
	2	3	4
Surface Access			
▶ Route			
✦ Shaw Creek Hillside all-season road[1]	X		
⏩ Shaw Creek Road/Rosa egress from Richardson highway	X		
⏩ New Tenderfoot egress from Richardson Highway	X		
✦ South Ridge all-season road		X	
✦ Shaw Creek Flats winter-only access			X
⏩ Traditional winter road construction standards			X
⏩ Perennial winter trail construction standards			X
▶ Road use during mine operations			
✦ Pogo project only	X	X	
✦ Pogo and other industrial/commercial users only	X	X	
✦ Everyone	X	X	
⏩ Security gate near end of Shaw Creek Road	X		
⏩ Security gate at Gilles Creek	X		
▶ Road disposition at end of mine operations			
✦ Remove and reclaim	X	X	
✦ Leave road open (versus closed) to:			
⏩ Industrial/commercial users	X	X	
⏩ Everyone	X	X	
Power Line Route			
▶ Shaw Creek Hillside	X		
▶ South Ridge		X	

[1] Underline – Applicant's proposed option or sub-option

Alternative 1

NEPA requires that a No Action Alternative be considered. The No Action Alternative would result from denial of at least one of the federal or state permits necessary for project development, or it could result if the Applicant chose not to develop the project. This alternative may be used as a baseline for comparison with the action alternatives to determine impacts. Table S-4 presents the No Action Alternative assumptions.

Table S-4 No Action Alternative Assumptions

1. Socioeconomics

- No prison constructed at Fort Greely
- Construction of a National Missile Defense System (NMDS) at Fort Greely beginning in 2002, with completion by approximately 2004 (~3 years).
- NMDS construction employment would average 400 jobs. Most of the construction labor force would be nonresidents and would be housed on site. The total NMDS-related population during operation (including employees, their dependents, and indirect population increase) would be approximately 350 residents.
- Natural gas pipeline construction between 2005 and 2008. Impacts on the Delta area would occur for 2 years during this period, with peak impact lasting for approximately 9 months. The large majority of workers would be nonresidents of Delta area. There would be almost no increase in population from actual gas pipeline operation.
- Once the NMDS is constructed, the Delta area population should stabilize at approximately 2,100 residents, below the pre-base closure peak of 2,388 residents in 1993.

2. Non-Resource Development

Residential land sales

- Some additional private residential land would be needed for a portion of NMDS workers. There would be no sales of state land in the project area. Natural gas pipeline construction would not increase residential land needs.
- State land sales would adhere to the State of Alaska's Tanana Basin Area Plan (TBAP).

Agricultural land sales

- New agriculture land sales in the Delta area unlikely in the near future unless there are substantial changes in operation expenses and the market and demand for farm-related products.

Commercial and Industrial Activities

- Existing, and possibly new, commercial and industrial activities (such as lodges, stores, and rock quarries) would occur in the existing developed Delta area at a pace consistent with ongoing needs or other actions in the area.

Power

- Golden Valley Electric Association's Fairbanks to Delta power line would be upgraded for NMDS. This upgrade would not require more or higher poles, nor more clearing of the right-of-way (ROW).

3. Resource Development

Timber

- The current Tanana Valley State Forest (TVSF) 5-year schedule for timber sales (Fiscal Year 2003 to 2007) would be implemented, given existing winter trail access routes and market demand. The current 5-year schedule proposes harvesting four timber sales on the northwest side of lower Shaw Creek. See Section 3.17.1 for greater detail.
- The State of Alaska Division of Forestry (DOF) would construct its planned all-season road to access timber along the Shaw Creek Hillside to harvest three of those sales totaling approximately 433 acres. This road likely would be constructed incrementally over the next several years, depending on sale of the proposed harvest units and additional capital funding. The road would be open to the public, and its route would be very similar to the route for the Shaw Creek Hillside all-season road proposed by the Applicant and would extend to Gilles Creek. Estimated total round trips on this road by logging trucks, for each of the three entire sales, are 142 (Fowler Creek), 285 (Keystone Bluff # 1), and 485 (Keystone Bluff # 2). These truck trips would average to between approximately 2 and 3 truck round trips per day.

Table S-4 No Action Alternative Assumptions

- The DOF eventually would construct its planned all-season road around Quartz Lake to access timber in the vicinity of Quartz Lake and Indian Creek near the South Ridge route all-season road option route. It would be open to the public. Like the proposed Shaw Creek Hillside forestry road, it likely would be constructed incrementally and would be dependent on additional capital funding or timber sale activity. The current 5-year schedule for timber sales proposes four timber sales in the Quartz Lake and Indian Creek area, totaling approximately 610 acres. Of that total, two sales totaling approximately 470 acres would be accessed from the proposed new DOF road, while one sale of approximately 80 acres northeast of Quartz Lake would be accessed from the existing winter road on Shaw Creek Flats. Estimated total sale harvest round trips on the DOF road by logging trucks, for each of the two entire sales using the road, are 266 (Quartz Lake # 1) and 950 (Indian Creek # 1). These truck trips would average between approximately 2 and 3 truck round trips per day.

Mining

- Mineral exploration likely would slow or perhaps decline from current levels either because a lack of Pogo Mine permits would cool mining companies' interest in the area, or because the Applicant decided not to proceed on economic grounds (e.g., low price of gold).

Recreation

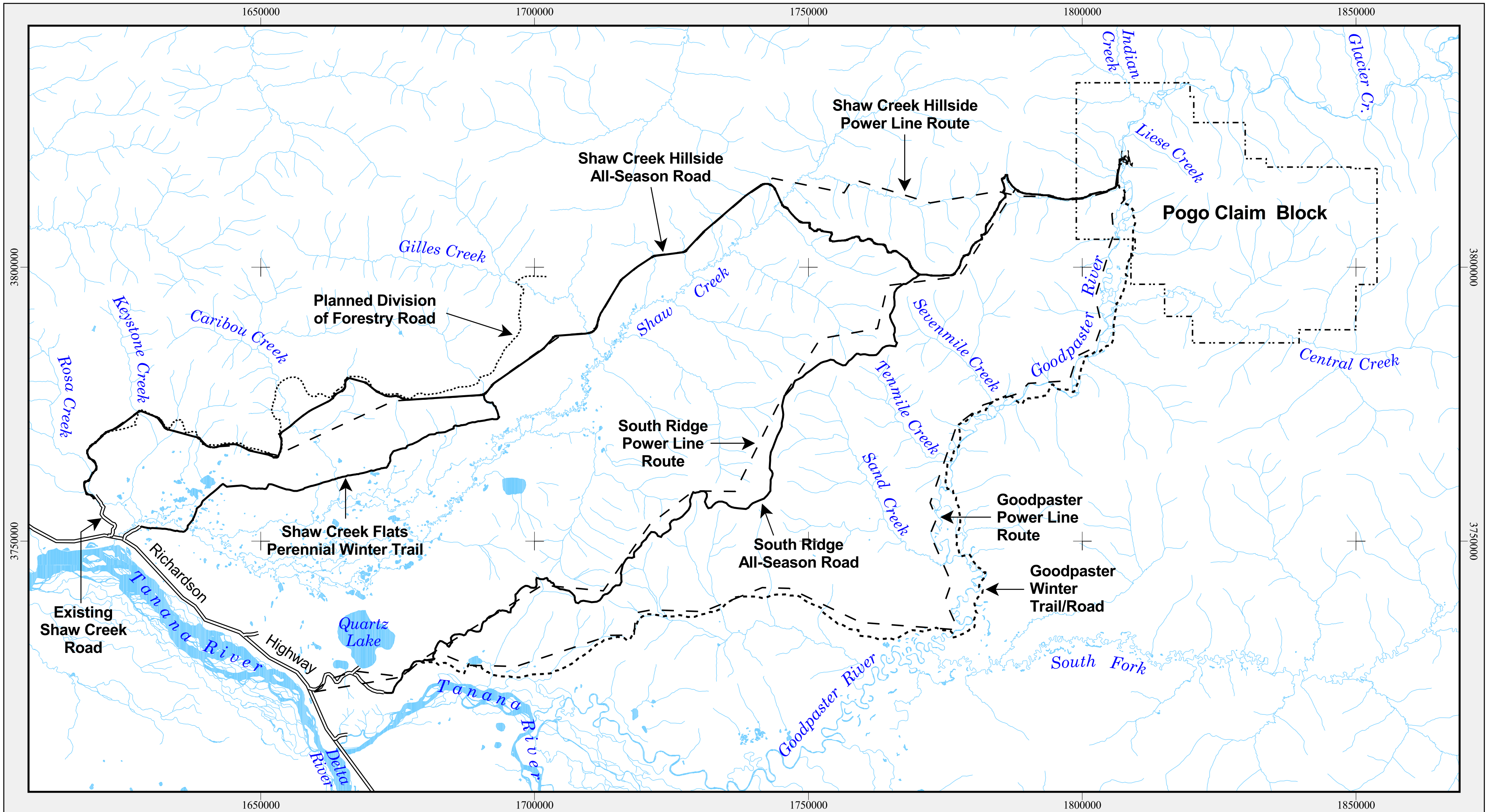
- Slow increase in use of the Goodpaster River Valley.

Alternative 2 (Applicant's Proposed Project)

In Alternative 2, the Applicant's proposed project, surface access to the mine would be by a 49.5-mile all-season road beginning at the end of the existing Shaw Creek Road, traversing the Shaw Creek Hillside, and then over the Shaw Creek/Goodpaster River Divide to the mine (Figure S-3). The road would only be used by Pogo project-related traffic, and it would be removed and reclaimed in its entirety at the end of mining operations. During intense periods of mine construction, traffic would average approximately 50 vehicles per day. Mine-related vehicle use would average between 10 and 20 round trips per day during operations, with up to 180 round trips by workers' vehicles on the initial 4.5 miles of the road during brief periods every 4 days for shift changes.

At the mine site (Figure S-4), ore from the underground mine would be ground and subject to a gravity/flotation/cyanide vat leach mill process. All tailings exposed to cyanide would pass through a cyanide destruction process and be deposited as a paste backfill underground in the mine. Non-cyanide exposed tailings would be deposited in an unlined surface dry stack in upper Liese Creek Valley located above an unlined RTP. Mineralized development rock would be encapsulated in the dry stack, and nonmineralized development rock would be used for constructing roads and other facilities.

The mill and camp would be located in lower Liese Creek Valley, and the construction camp would be located at the existing exploration camp site near the existing 1525 exploration portal. Laydown areas would be located near the existing 1525 Portal, at the airstrip, and at the mill. Gravel would be mined from existing and new pits on the Goodpaster Valley floor and in upper Liese Creek Valley.



N
W E
S

Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

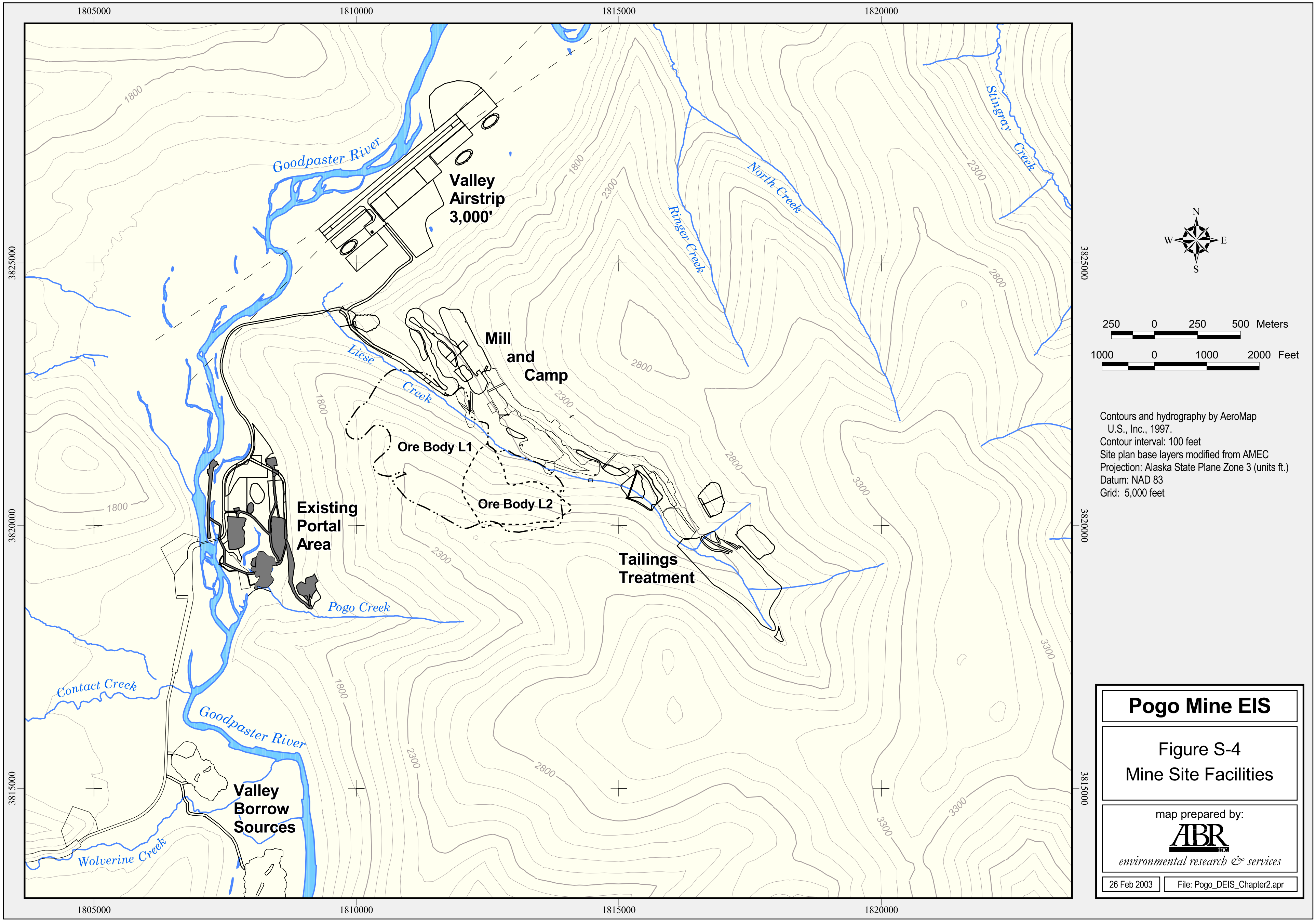
5 0 5 10 15 Kilometers
2 0 2 4 6 8 Miles

Pogo Mine EIS

Figure S-3 Surface Access and Power Line Route Options, and Planned Forestry Road

ABR inc. map prepared by: environmental research & services

26 February 2003 | ABR File: Pogo_DEIS_Chapter2.apr



Pogo Mine EIS

Figure S-4
Mine Site Facilities

map prepared by:
ABR inc.
environmental research & services

26 Feb 2003 | File: Pogo_DEIS_Chapter2.apr

Power would be supplied by a 50-mile power line that would follow the access road. Diesel fuel would be stored in permanent tanks at the mill and at the mouth of the 1525 Portal. Water would be supplied from mine drainage, the RTP, and wells. During the development phase, treated industrial wastewater would be injected into underground wells. During operations, treated industrial wastewater would be discharged to a soil absorption system

(SAS) adjacent to the airstrip, or injected into underground wells. Treated domestic wastewater would be discharged to underground drain fields at the camp in Liese Creek Valley and at the existing exploration camp near the 1525 Portal.

A 3,000-foot airstrip would be located on the Goodpaster Valley floor just north of the mouth of Liese Creek.

Alternative 3

Alternative 3 would be the same as Alternative 2 except:

- The surface dry stack and RTP would be lined
- During development and operations, treated industrial wastewater would be discharged directly to the Goodpaster River
- Surface access would be via the South Ridge all-season road
- The power line would follow the South Ridge all-season road route

Alternative 4

Alternative 4 would be the same as Alternative 3 except:

- Power would be supplied by on-site generation
- During development and operations, treated industrial wastewater would pass through an off-river treatment works before discharge to a channel into the Goodpaster River
- Surface access would be via a winter-only road or trail across Shaw Creek Flats to an all-season road beginning south of Gilles Creek that then would follow the Alternative 2 road route to the mine site

S.9 Mitigation, Monitoring, and Management

Environmental mitigation, monitoring, and management measures are designed to ensure that potential impacts would be minimized during construction, operation, and closure of the Pogo Gold Mine project. In general, the Applicant has incorporated extensive mitigation and monitoring measures into its plan of operations. These measures include likely requirements of the permits and approvals for the project. In addition, the State of Alaska as landowner has adopted several land management measures to minimize impacts.

S.10 Closure and Reclamation

The Applicant has submitted a reclamation and closure plan. The goal of the plan is to return disturbed land to the designated post-mining land use, defined by the Tanana Basin Area Plan (TBAP) as public recreation and wildlife habitat. The goal of reclamation is to re-establish wildlife habitat within 5 to 15 years by stimulating growth of an early successional vegetation. The primary objective of the closure part of the plan is to ensure that water quality would not be strongly affected after mine closure. To accomplish this objective, materials that potentially could cause degradation to the lands and waters of the state would be stabilized, removed, or mitigated.

The primary objective of the reclamation part of the plan would be to stabilize disturbed mined-land surfaces against erosion. This stabilization would be accomplished by improving plant growth conditions and encouraging the succession of self-sustaining native and naturalized plant communities. Inactive areas not anticipated to be disturbed would be closed and reclaimed concurrently with mining.

S.11 Environmental Consequences

The impacts of the three action alternatives are summarized in three tables in Appendix A of this summary. Table A-1 shows the impacts from options that are common to all alternatives. That is, if the project were to proceed to development, these impacts would occur regardless of which alternative were selected.

Table A-2 summarizes the impacts of options that are specific to one of the three action alternatives, but that are not access related. Finally, Table A-3 summarizes options that are specific to one of the three action alternatives, and that are access related. The descriptions of impacts assume the recommended mitigation measures would be implemented. Note that as a convention, if a particular option would have no, or only a low, impact on a given resource, it generally is not discussed.

Cumulative Impacts

Cumulative impacts "result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative impacts can result from individually minor impacts that, when viewed collectively over space or time, can produce significant impacts" (40 CFR 1508.7).

Examination showed that the overwhelming factor determining cumulative impacts was whether the all-season access road would be removed and reclaimed at Pogo Mine closure, or whether it would be maintained for other resource development purposes and/or for public use. This factor applied not only to Alternatives 2 and 3, which contain a complete all-season road by definition, but also to Alternative 4 with its winter-only access option. The factor of road access and retention was important because it would be highly likely that by the time of Pogo Mine closure, the planned Division of Forestry (DOF) road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and be effectively operated like the complete all-season road options for Alternatives 2 and 3. Thus, the critical issue affecting cumulative impacts was not a choice of which alternative; rather, it was a management issue. That is, at Pogo Mine closure, would the road be removed and reclaimed, or would it be left in place for other resource development purposes and for public use?

Table A-4, also in Appendix A, summarizes the impacts from a resource-by-resource perspective on the basis of whether the all-season access road would be removed and reclaimed at Pogo Mine closure, or would be maintained for other resource development purposes and public use.

S.12 Identification of the Environmentally Preferable and Preferred Alternatives

In making its Record of Decision, EPA must identify both an Environmentally Preferable Alternative and a Preferred Alternative. The Environmentally Preferable Alternative "ordinarily, means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources" (Council on Environmental Quality [CEQ], 1981: Forty most asked questions, no. 6a). The Environmentally Preferable Alternative can be the same as the agency Preferred Alternative or differ in some respects, depending on the analysis in the EIS.

The Preferred Alternative is the alternative EPA and the cooperating agencies believe fulfills the purpose and need of the proposed action. As provided for in NEPA and the CEQ NEPA implementing regulations, the Preferred Alternative and the Environmentally Preferable Alternative need not be the same. EPA may take into account various other considerations in choosing its Preferred Alternative, including such factors as the agency's statutory mission and responsibilities and economic, environmental, technical, and social factors.

An analysis of the impacts that are summarized in Tables A-1 through A-4 was conducted on an individual component basis to determine which options should constitute both the Environmentally Preferable Alternative and EPA's and the cooperating agencies' Preferred Alternative. That analysis is contained in the following three subsections.

S.12.1 Options Common to All Alternatives

By definition, the options common to all alternatives would be developed, regardless of which of the three action alternatives were selected. Of the ten project components with options common to all alternatives, eight had no sub-options that differed between the three action alternatives (Table S-1). Two components, however, did have options that would produce different impacts; gravel source, and use and disposition of the airstrip.

Gravel Source

Gravel Pits Versus Crushing Development Rock Gravel is on the critical path for project construction, and would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable.

Experience in the existing advanced exploration adit at Pogo has demonstrated that underground development rock breaks down under traffic loads and becomes mud. It does not posses the necessary hardness specifications, and thus crushing development rock to make gravel would not be feasible or practicable from the technical perspective.

Mining gravel from existing and new pits would disturb approximately 66 more acres, approximately 13.1 acres of which would be excavated for the off-river treatment works. A portion of this disturbance would be to wetlands, and would have moderate impacts. But those impacts would be offset by pond creation in the gravel pits, resulting in negligible overall wetlands impact. Mining gravel would have a moderate local wildlife habitat impact although this, too, would be mitigated somewhat by pond formation. Still, surface mining of gravel would account for approximately 7 percent of the total surface disturbance for the Applicant's Proposed Project.

Summary analysis indicated that from the timing and technical perspectives, crushing development rock to make gravel would not be feasible or practicable. For the gravel mining option, overall impacts to wetlands and wildlife would be low to moderate on a local basis, with some positive benefits from newly created ponds in the gravel pits. And, construction of the off-river treatment works would require excavating approximately 13.1 acres of gravel in any event. Therefore, the option to mine gravel was selected as the Preferred Alternative and, because crushing development rock to make gravel would not be feasible or practicable, mining gravel also was the Environmentally Preferable Alternative by default.

Air Access

- **Airstrip use and disposition** Summary analysis indicated that allowing airstrip use by other industrial/commercial users, or everyone, during operations would have more impacts than restricting use only to the Pogo project. In a similar manner, removing and reclaiming the airstrip would have fewer impacts on most resources, and the area land use plan does not call for creating access to the mid-Goodpaster River Valley. Therefore, for both the Environmentally Preferable Alternative and the Preferred Alternative, use only by the Pogo project was selected as the airstrip use option, and removal and reclamation was selected as the airstrip disposition option.

S.12.2 Options Specific to Alternatives, But Not Related to Surface Access

Three project components had options that were specific to one of the three action alternatives, but were not related to surface access (Table S-2).

Tailings Facility Liner

- **Lined Versus Unlined Tailings Dry Stack and RTP**

Dry-stack tailings pile Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability perspective, however, a liner would be more problematic.

The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk.

Because there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner, the unlined dry stack sub-option was selected as both the Environmentally Preferable Alternative and the Preferred Alternative.

In the Applicant's Proposed Project, there would be no erosion control/drainage blanket installed before tailings would be placed in the dry-stack tailings facility. This blanket was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation. Because of this benefit, inclusion of a erosion control/drainage blanket was selected for both the Environmentally Preferable Alternative and Preferred Alternative.

RTP The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities.

Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cutoff wall.

The proposed RTP dam face liner system and grout curtain would establish an effective interception cutoff wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock.

A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including:

- A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cutoff wall required to collect the subsurface seepage. If such a cutoff wall at the upgradient end of the liner were required, it would follow that another liner upstream of that cutoff wall also would be needed, etc. It is thus a cutoff wall perpendicular to the flow that would be needed to capture seepage, not a liner.
- Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume.
- The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V).

Because a full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage, and because the geometry of the site exceeds recommended slopes for effective installation of a liner, the unlined option was selected for both the Environmentally Preferable Alternative and the Preferred Alternative.

Power Supply

- **Power Line Versus On-Site Generation** Summary analysis indicated that for the majority of resources the risk from fuel spills during transportation was considered to be substantially more important than the impacts from the clearing required for a power line right-of-way (ROW), especially because clearing generally would not destroy the vegetative mat and once the power line were reclaimed, the visual impacts would be removed and plant succession would eventually return the ROW to approximately its present condition. Thus, the power line was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

Water Discharge

Water discharge had two subcomponents: the project development phase and its operations phase.

Development Phase This subcomponent had three options for treated wastewater: underground well injection, discharge to the Goodpaster River, and an off-river treatment works.

- **Underground Injection Well**. The existing water treatment plant at Pogo has discharged treated mine drainage via an injection well at approximately 100 gpm since 1999. Every monthly sample during the four-year period since has met all the permit limits of the existing injection well permit. As the mine workings increase over the first two years of development, however, the amount of water to be discharged could increase to approximately 400 gpm. And, the farther one gets in both space and time from the existing conditions the more potential there would be for mine drainage water quality to diverge from that observed during the past four years. There would be potential for discharged water to surface in nearby sloughs, and the projected treated water may not meet discharge criteria for four parameters at least some of the time. If mercury did not exceed, or infrequently exceeded, its criterion, this would be considered a moderate impact from a permitting and compliance perspective.
- **Discharge to the Goodpaster River**. Treated wastewater would be discharged directly to the Goodpaster River. Water quality at the edge of the mixing zone was projected to meet discharge criteria for all parameters. The impact of this discharge was expected to be low.

  A mixing zone could not be approved if there were potential for mercury to bioaccumulate to significantly adverse levels [18 AAC 70.250 (a)(1)(A)]. It was uncertain whether mercury would bioaccumulate to significantly adverse levels from this discharge; hence, it was uncertain whether a mixing zone could be granted.
- **Off-River Treatment Works** This option was expected to have efficient mixing of treated wastewater, thus meeting criteria for all parameters even at the conservative 95th percentile of the annual maximum. The impact of this discharge was expected to be low.

Summary analysis of the development-phase discharge options determined that for the underground injection wells option the discharge may not meet criteria for six parameters at least some of the time. This inability to meet discharge criteria was considered to have a moderate impact from a permitting and compliance perspective only if mercury only infrequently exceeded its criterion. For the direct discharge option, it was unknown whether a mixing zone could be granted because of the lack of certainty about whether mercury would bioaccumulate. In contrast, the off-river treatment works option was expected to have a low impact and more permitting certainty. Thus, the off-river treatment works was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

Operations Phase This subcomponent had the same three options for treated wastewater as the development phase, plus discharge to a SAS. Impacts from the three options in common with the development phase would be the same as discussed above for the development phase.

Soil absorption system. The influent to the SAS is expected to achieve drinking water standards for the 95th percentile of the annual average for all parameters except nitrate, and is expected to exceed TDS, chloride, sulfate, TKN, and nitrate for the 95th percentile of the annual maximum. The effluent from the SAS is expected to exceed the discharge criteria for the 95th percentile of the annual average based on dissolved and total concentrations for nitrate, cyanide, cadmium, copper, lead, and mercury. The 95th percentile of the annual average would also exceed the total recoverable criteria for manganese. For the 95th percentile of the annual maximum, TDS, chloride, sulfate, nickel, and selenium would be exceeded for dissolved and total criteria in addition to those exceeded for the annual average. Manganese would also be exceeded for total criteria only. These additional parameters at the 95th percentile of the annual maximum would likely exceed the discharge criteria less frequently than for the 95th annual average. Because the influent to the SAS and the discharge from the SAS are estimated to exceed the expected discharge criteria for a number of parameters, this discharge was defined as having a high impact from a permitting and compliance perspective, and may not be permittable.

Summary analysis for the operations phase options determined the same impacts as described for the same development phase options, in addition to the high permitting and compliance impact for the SAS option. Thus, in the same manner as for the development phase, the off-river treatment works was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

S.12.3 Options Specific to Alternatives, and Related to Surface Access

Two project components had options related to surface access specific to one of the three action alternatives: surface access and power line route (Table S-3).

Surface Access

The surface access component had three subcomponents: route, use, and disposition.

Route There were three route options: Shaw Creek Hillside all-season road, South Ridge all-season road, and the Shaw Creek Flats winter-only access.

- **Winter-only access** In the first route analysis, the concept of winter-only access was compared to the all-season road concept. Implementation of each concept would have advantages over the other for several issues. From the technical and economic feasibility perspectives, however, the winter-only access concept would not work. Technically, the issue was whether the annual winter-only access option would be feasible during the life of the mine. The Applicant estimated that a winter supply window allowing adequate time would be absent once in 13 years. Independent confirmation of recent long-term climate warming in central Alaska suggested the Applicant's estimate was optimistic.

From an economic feasibility perspective, constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-foot airstrip susceptible to weather interruptions for the remainder of the year, raised many issues. These issues included a short window for mobilization of construction equipment and supplies for the development phase, including construction of the all-season road segment; capital costs estimated to be approximately 53 percent higher than for an all-season road; storage of an entire year's worth of diesel, propane, cement, reagents, and other materials at the mine; and total annualized operating costs estimated to be approximately 118 percent higher than for an all-season road, with freight estimated to cost approximately 60 percent more per ton and with substantial personnel air transportation costs.

Thus, because winter-only access might not be possible for 1 or more years during expected mine life, and because it would add substantial capital and operating costs that would increase the project's economic burden, it would introduce an unreasonable level of complexity and business risk. Therefore, this option did not address the purpose and need for the proposed action, and could not be considered further for the Preferred Alternative.

- **All-season road** In the second route analysis, the options for the Shaw Creek Hillside all-season route and South Ridge all-season route were compared. For purposes of the analysis, impacts from the associated power line routes also were considered because, taken as a whole, building both the road and power line in conjunction would substantially reduce total impacts from both components. Analysis showed each set of options (for the road and power line) to have advantages over the other.

The South Ridge route had advantages in that it would cause approximately 79 fewer acres of total surface disturbance for both the all-season road and power line ROWs, and approximately 45 fewer acres of cuts and fills in wetlands. It also would cross only one stream requiring a bridge (the Goodpaster River), versus seven for the Shaw Creek Hillside route.

The Shaw Creek Hillside route had advantages in that it would disturb roughly half the acreage of high-value habitats for moose, caribou, and brown bear than would the South Ridge route, and bird-power line collisions likely would be lower because of its more extended length below timberline. Visual impacts also would be fewer than for the South Ridge route because it would be primarily below timberline, and the Shaw Creek Hillside route would not be visible to the recreational cabin owners on the lower Goodpaster River. Therefore, the Shaw Creek Hillside all-season road would be more consistent with the visual guidelines of the TBAP, which call for consideration of visual impacts on the Goodpaster River corridor.

In all cases, these differences in impacts between the two routes were not considered to be high on greater than a local basis, largely because the route corridors would be narrow and linear in character, and because mitigation measures would reduce impacts.

The overriding difference between the routes, however, was related to land use. Based on the long-term Tanana Valley State Forest (TVSF) Management Plan, the current DOF 5 year timber harvest plan includes an initial forestry road to the Keystone Bluffs area of the state forest, and eventually well up the Shaw Creek Valley to upper Gilles Creek. Therefore, within the expected life of the Pogo Mine, there is a reasonable probability that a public road up to 23 miles long would be constructed very close to the proposed Shaw Creek Hillside all-season road alignment as far as Gilles Creek if the Applicant's proposed road were not constructed. Thus, because there were no major differences in impacts between the two route options that could not be mitigated to some extent, and because constructing the Shaw Creek Hillside route would result in only one road being built into the project area (i.e., not both the South Ridge all-season road and the DOF forestry road), the Shaw Creek Hillside route was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

For the Shaw Creek Hillside all-season road option, there was an issue of what route would be used to connect the all-season road to the Richardson Highway.

- **Richardson Highway egress** There were two route sub-options for this road segment: the existing Shaw Creek Road and Tenderfoot.

  For most resources, there were no or only minor differences between the two sub-options. The Shaw Creek Road sub-option, however, had higher noise and safety impacts and would not be as favorable to new recreational users, while the Tenderfoot sub-option was determined to have higher visual and cost impacts. Of these, the noise, safety, and cost impacts were judged to be of most importance.

  For the Shaw Creek Road sub-option, both the safety and noise impacts generally were considered low. From the safety perspective, some increased impact would occur, especially if the all-season road were open to use by everyone and the shift change bus station were located near the Trans-Alaska Pipeline System (TAPS) crossing. This increased impact, however, could largely be mitigated. From the noise perspective, impacts generally would be low or moderate. If the Applicant's shift-change bus station were near the TAPS crossing, however, two residences would experience a moderate to high impact, and four would experience a high impact during short periods of time 4 days apart. These impacts also could be mitigated to some extent, including locating the bus station on the Richardson Highway.

  Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State of Alaska has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. Because the road could be upgraded in the future if necessary, speed limits could be adjusted and other mitigation measures implemented as appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low.

  For the Tenderfoot sub-option, the cost of a new approximately 3.5-mile road was estimated at approximately $2.5 million to $3.0 million. This road would terminate in the vicinity of the end of the existing Shaw Creek Road, which already is a state-maintained road.

In final analysis, it was determined that it would be unreasonable to build a new road merely to avoid an existing state-maintained road, considering that the Shaw Creek Road noise and safety impacts generally would be low, or could be mitigated to make them low.

Use For road use during Pogo project operations, there were three options:

- **Pogo Project Use Only**

- **Pogo Project and Other Industrial/Commercial Users**
- **Use by Everyone**

For almost all resources, impacts were considered to be low from the regulated use of an all-season road only by the Pogo project, and were considered only marginally higher for additional regulated use by other industrial/commercial users. Impacts from the option with use of the road by everyone were considered generally low for several resources (water and air quality, noise, wildlife, and visual), and moderate for fish. For three resources, however, impacts were considered high.

Because off-road use by ATVs and other vehicles generally is not regulated, a road open to everyone could cause major impacts to wetlands. It also would increase competition for subsistence resources. For existing recreationists, road use by everyone could have a major impact on the quality of their experiences, particularly for cabin owners along the lower Goodpaster River. Conversely, from the perspective of new recreationists, use by everyone would be beneficial because it would provide access to new areas.

In determining its preferred option, the ADNR considered its overall, broad management goals under the TBAP, as well as the more specific management objectives of the TVSF plan. Because (1) the Shaw Creek Hillside route would be both within or immediately adjacent to the state forest in lower Shaw Creek Valley; (2) an objective of the forest plan is to provide public access to forest resources; and (3) state forest roads generally are open to the public; ADNR made a proposed determination that the lower approximately 23 miles of the Shaw Creek Hillside all-season road as far as Gilles Creek would be open to public use during mine life following Pogo project construction, and published that preliminary decision in the DEIS. The proposed determination would have kept the remaining approximately 26 miles of road to the mine open only for use by the Pogo project, and possibly to other industrial/commercial users on a case-by-case basis. Such other use could occur, however, only after a public process and thorough analysis of potential impacts of the proposed uses.

Public and Tribal comments on ADNR's preliminary decision, however, were overwhelmingly opposed to opening any of the Shaw Creek Hillside all-season road past the end of the existing Shaw Creek Road to the public during the life of the Pogo Mine. ADNR, therefore, is reconsidering its preliminary decision and the EIS team has selected use of the entire mine access road during the life of the mine only by the Pogo project, and by other industrial/commercial users on a case-by-case basis, as the Preferred Alternative for purposes of this final EIS. ADNR will consider whether to adopt this option in its final decision to be made after publication of this final EIS. Use of the entire road only by the Pogo project (with no use by other industrial/commercial users) was determined to be the option for the Environmentally Preferable Alternative.

Disposition There were two all-season road disposition options:

- **Remove and Reclaim the Road**
- **Maintain the Road**

Results of this analysis were similar to those for the road use options discussed above. The primary difference was that the option for road use during mine operations had a limited time horizon while road disposition following Pogo Mine closure was considered to be permanent. Continued road use only by industrial/commercial users was considered to have low impacts on most resources, although locally high impacts on wetlands and wildlife could happen if major resource developments were to occur.

Leaving the road open to everyone would perpetuate many of the same impacts described in the Chapter 4 alternatives analysis of the option to permit road use by everyone. In addition, it would lead to the cumulative impacts of maintaining an all-season road also described in that chapter. As discussed in Chapter 4, the degree of impacts if the road were to be maintained, particularly cumulative impacts, could be reduced in large measure by the State of Alaska land use and road management policies.

The probability of another mine or other large resource development occurring in the area prior to Pogo Mine closure is low. The TVSF Management Plan, however, contemplates public use of state forest roads. Therefore, ADNR made a preliminary determination in the DEIS that the ROW authorization for the Shaw Creek Hillside all-season road would require that at Pogo Mine closure the all-season road must be removed and reclaimed from Gilles Creek to the mine site in its entirety, and in a manner that would preclude use by ATVs. The segment from the existing Shaw Creek Road to Gilles Creek, however, would remain open for all users. ADNR could extend the life of the road to the mine site to accommodate other major resource development projects, but only after a public process that would include a thorough analysis of potential impacts of the proposed uses.

Comments on ADNR's preliminary disposition decision strongly favored opening the mine access road as far as Gilles Creek after the life of the mine. Thus, because the TVSF Management Plan contemplates public use of state forest roads, and because there was strong support for public use of the road after the mine's life, public use of the road as far as Gilles Creek was determined to be the Preferred Alternative, while removal and reclamation of the entire all-season road was determined to be the Environmentally Preferable Alternative.

Power Line Route

The power line route component had two options:

- **Shaw Creek Hillside Route**
- **South Ridge Route**

While these two options had different impacts for various resources, a constant throughout the power line route analysis was that the power line route should be the same as the surface access route because, taken as a whole, building both in conjunction would substantially reduce total impacts from both components. Because overall impacts from the surface access route would be substantially greater than those for the power line route, and because neither power line route offered any substantial benefits over the other, once the surface access route was selected the choice of the corresponding power line route was straightforward. Thus, the Shaw Creek Hillside power line route was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide. The road corridor route would have approximately the same direct habitat impact as the Sutton Creek route, and marginally greater wetlands impacts, but would consolidate impacts into one corridor and avoid all impacts to the Sutton Creek drainage. Thus, the road corridor sub-option was selected for both the Environmentally Preferable Alternative and the Preferred Alternative.

S.13 Presentation of the Environmentally Preferable and Preferred Alternatives

Based on the impacts analyses described above, Tables S-5, S-6, and S-7 present the Environmentally Preferable Alternative, as well as EPA's and the cooperating agencies' Preferred Alternative.

Figure S-5 presents EPA's and the cooperating agencies' Preferred Alternative in graphic form in the same manner as was shown earlier in Figure S-2, except the options that constitute the Preferred Alternative are boldly framed.

The options and sub-options selected for the Environmentally Preferable Alternative and the Preferred Alternative were the same for every project component with the exception of use and disposition of the Shaw Creek Hillside all-season road. For these two subcomponents, the Environmentally Preferable Alternative was for use only by the Pogo project, and for complete removal and reclamation of the road, respectively. In the Preferred Alternative, use and disposition of the road was the same as for the Environmentally Preferable Alternative past Gilles Creek. Between the existing Shaw Creek Road and Gilles Creek, however, public use would be allowed following the project's construction, and the road would be maintained for public use following mine closure.

Table S-5 Environmentally Preferable Alternative and Preferred Alternative for the Options Common to All Action Alternatives

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Milling Process		
▶ Gravity / flotation / cyanide vat leach[1]	X	X
Tailings Disposal		
▶ Underground paste backfill	X	X
▶ Surface dry stack and RTP in Liese Creek Valley	X	X
Mill and Camp Location		
▶ Liese Creek Valley	X	X
Development Rock Disposal		
▶ Mineralized rock encapsulated in dry stack	X	X
▶ Nonmineralized rock in dry stack, RTP dam, other construction	X	X
Gravel Source		
▶ Expand existing gravel pits and develop new pits	X	X
▶ Crush nonmineralized development rock		
Construction Camp		
▶ Below existing 1525 Portal in Goodpaster Valley	X	X
Laydown Area		
▶ Permanent below existing 1525 Portal, at airstrip, and at mill	X	X
Water Supply		
Industrial		
▶ Mine drainage	X	X
▶ RTP	X	X
▶ Wells	X	X
Domestic		
▶ Wells	X	X
Water Discharge		
Operations Phase		
▶ Domestic wastewater		
✦ Package treatment plant and direct discharge to river	X	X
Fuel Storage Location		
▶ Temp: 1525 Portal and airstrip. Perm: portal mouth and mill	X	X
Air Access		
▶ 3,000-foot airstrip in Goodpaster Valley	X	X
▶ Use of airstrip during Pogo mine operations		
✦ Pogo project only	X	X
✦ Pogo and other industrial / commercial users only		
✦ Everyone		
▶ Disposition of airstrip at end of Pogo project		
✦ Remove and reclaim after mine reclamation	X	X
✦ Open for Industrial / commercial resource users only		
✦ Open for everyone		

[1] Underline – Applicant's proposed option or sub-option

Table S-6 Environmentally Preferable Alternative and Preferred Alternative for the Options Specific to Certain Action Alternatives, but <u>Not Related to Surface Access</u>

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Tailings Facility Liner		
▶ <u>Surface dry stack and RTP in Liese Creek</u>[1]	X	X
✦ Lined dry stack		
✦ Lined RTP		
✦ <u>Unlined dry stack</u>	X	X
✦ <u>Unlined RTP</u>	X	X
Power Supply		
▶ <u>Power line</u>	X	X
▶ On-site generation		
Water Discharge		
Development Phase		
▶ <u>Underground injection wells</u>		
▶ Direct discharge to Goodpaster River		
▶ Off-river treatment works	X	X
Operations Phase		
▶ Industrial wastewater (RTP)		
▶ Industrial wastewater (RTP)		
✦ <u>Soil absorption system (SAS)</u>		
▸▸ <u>Goodpaster River Valley adjacent to airstrip</u>		
▸▸ Saddle above and southeast of Pogo Ridge		
✦ <u>Underground injection wells</u>		
✦ Direct discharge to Goodpaster River		
✦ Off-river treatment works	X	X

[1] <u>Underline</u> – Applicant's proposed option or sub-option

Table S-7 Environmentally Preferable Alternative and Preferred Alternative for the Options Specific to Certain Action Alternatives that are Related to Surface Access

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Surface Access		
▶ Route		
✦ Shaw Creek Hillside all-season road[1]	X	X
›› Shaw Creek Road egress from Richardson Highway	X	X
›› New Tenderfoot egress from Richardson Highway		
✦ South Ridge all-season road		
✦ Shaw Creek Flats winter-only access		
›› Traditional winter road construction standards		
›› Perennial winter trail construction standards		
▶ Use of all-season road during Pogo mine operations		
✦ Pogo project only	X	
✦ Pogo and industrial/commercial users		X
✦ Everyone		
›› Security gate near end of Shaw Creek Road	X	X
›› Security gate at Gilles Creek		
▶ Disposition of all-season road at end of mine operations		
✦ Remove and reclaim — entirely	X	
✦ Remove and reclaim — past Gilles Creek gate		X
✦ Leave road open as far as Gilles Creek (vs. closed) to:		
›› Industrial/commercial users	X	
›› Everyone		X
Power Line Route		
▶ Shaw Creek Hillside	X	X
▶ South Ridge		

[1] Underline – Applicant's proposed option or sub-option

PREFERRED ALTERNATIVE (Shown In Bold Frames)

AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1] =	COMPONENTS NOT SURFACE ACCESS RELATED		WATER DISCHARGE		COMPONENTS SURFACE ACCESS RELATED: ACCESS				
	TAILINGS FACILITY LINER +	POWER SUPPLY +	DEVELOPMENT PHASE +	OPERATIONS PHASE +	TYPE +	ROUTE +	USE +	DISPOSITION +	POWER LINE ROUTE
	Options	Options	Options	Options	Options	Options	Options	Options	Options
ALTERNATIVE 1 NO ACTION	Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented.								
ALTERNATIVE 2 Applicant's Proposed Project	**Unlined**	**Power Line**	Injection Wells	▪ Injection Wells, and ▪ SAS ◆ At Airstrip ◆ Above Pogo Ridge	**All-Season Road**	**Shaw Creek Hillside Richardson Egress ▪ Shaw Creek Road** ▪ Tenderfoot	**Pogo Project Only[2]** Pogo and: ◆ Industrial/ Commercial ◆ Everyone	**Remove/Reclaim[3]** **Road Left Open to: ◆ Industrial/ Commercial[4] ◆ Everyone[4]**	**Shaw Creek Hillside**
ALTERNATIVE 3 South Ridge Route Direct Discharge	Lined	"	Direct Discharge to Goodpaster River	Direct Discharge to Goodpaster River	"	South Ridge	"	"	South Ridge
ALTERNATIVE 4 Winter Only Access Off-River Treatment Works	"	On-Site Generation	**Off-River Treatment Works**	**Off-River Treatment Works**	Winter Access Only	Shaw Creek Flats	N/A[5]	N/A	N/A
Major Options Eliminated From Further Consideration[6]			Constructed Wetlands		Railroad Air Only (5,000-ft Airstrip)	Richardson Egress: ▪ Pipeline ▪ Keystone Dean Cummings Crossing Goodpaster Valley		Convert to Recreational Trail	

[1] Excludes those components/options common to all alternatives (Table 5.3-1).
[2] Entire access road past end of existing Shaw Creek Road
[3] Past Gilles Creek
[4] Up to Gilles Creek
[5] Not applicable to this alternative.
[6] See Appendix A.1.

Figure S-5

Executive Summary Appendix A

Table A-1 Summary of Direct and Indirect Effects of the Options Common to All Alternatives

4.1 Surface Water Hydrology

Mine area. Placement of the dry stack, RTP, mill facilities, and associated water diversion ditches would result in substantial modification of the surface water hydrology in Liese Creek. These impacts would be localized to Liese Creek with very small impacts to the Goodpaster River. Other option impacts would be low.

4.2 Groundwater Hydrology

Mine area. Dewatering of the mine would have moderate impacts on the groundwater hydrology in the vicinity of the mine and Liese Creek Valley. Installation of an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact the quantity of seepage from the dry stack that would enter the ground water. The overall impacts on groundwater flow in the Goodpaster River Valley would be very low.

Overall impacts on groundwater flow in the Goodpaster River Valley would be very low. Impacts from other component options would be low.

4.3 Water Quality

General mine area. Impacts on Liese Creek below the RTP would be low during operations. Installation of an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact either the quantity or quality of the seepage from the dry stack. Following closure, the RTP would be drained and capped with fill overlain with rock as a mitigation measure to protect sediments from erosion. Draining and capping would reduce potential impacts to a low level.

After mine closure, seepage of ground water from the mine would transport dissolved constituents to the slope and valley alluvium. Moderate increases in concentrations could occur for some parameters over the long term of 100 to thousands of years. These impacts would be localized between the mine and the river. Minimal impacts are expected on Goodpaster River water quality.

During operations, moderate impacts would occur to water quality in Liese Creek between the tailings dry stack and the RTP from runoff and seepage from the dry stack and mineralized development rock. After closure of the dry stack, water quality would improve.

Domestic wastewater would be treated with a single ADEC-approved package sewage treatment plant, and then discharged directly to the Goodpaster River. A mixing zone would be required in the river, but it is expected that the discharge would result in low to very low impacts.

Air access. Without mitigation, use of the airstrip could result in a large spill that could have a high impact on water quality. With use of planned secondary containment and additional best management practices (BMPs), the likelihood and severity of spills would be reduced and the overall impact would be low. Use of the airstrip only by the Pogo project would have the smallest potential to affect water quality. The potential for impacts to water quality would increase with more users. At the end of the Pogo Mine life, removing and reclaiming the airstrip would have the least impact while keeping it open for all users would have the highest potential for impacts on water quality due to fuel spills.

4.4 Air Quality

Mine area. Construction would cause short-term, localized impacts on soils, vegetation, and visibility in the immediate mine area as a result of fugitive dust. Construction and mine operation equipment and generators would release combustion products locally. These impacts would be low and inconsequential.

4.5 Noise

General mine area. Because the distances to noise-sensitive receivers in the lower Goodpaster River, Shaw Creek Road, Quartz Lake, Big Delta, and Delta Junction areas would be in excess of 15 miles, initial mine area blasting noise was projected to have not impact in these areas. Once blasting moved underground, there would be no surface impacts. Mine area operational noise would not be audible at sensitive receivers in these areas even under extreme conditions.

During initial construction, noise levels on the Goodpaster River between Pogo and Liese creeks were projected to range from 30 to 40 decibels (a-weighted) (dBA). Mine operational noise levels in this same area were projected to range from 25 to 35 dBA. Because this area is primarily used for recreation with outboard motors in the summer and snow machines in the winter, noise impacts would be low.

Table A-1 Summary of Direct and Indirect Effects of the Options Common to All Alternatives

4.6 Wetlands

General mine area. Alternative 3 would require filling 1 more acre of wetland than Alternative 2 at the airstrip. Alternative 4 would require clearing 6 acres less wetlands than Alternative 2 or 3 because a power line would not be built at the mine. Alternative 4 would require filling 12 to 13 more acres of wetlands than Alternative 2 or 3 because of increased storage space needed for a year's fuel and other supplies.

Mill, camp, and tailings disposal impacts would be high only in context of Liese Creek Valley. Impacts of facilities on the Goodpaster Valley floor also would be locally high, with gravel pits providing some wetland benefits if they were to become ponds.

	Alternative		
	2	3	4
Cut/fill (acres)	152	153	165
Clear only (acres)	14	14	8

4.7 Surface Disturbance

General mine area. Approximately 383 acres of disturbance would occur. There would be no substantive differences in disturbance among the alternatives, except for the gravel source option. If gravel were made from crushed mine development rock, as opposed to being mined from gravel pits, 72 fewer acres would be disturbed, leaving a total of approximately 311 acres of disturbance.

4.8 Fish and Aquatic Habitat

Air access. Impacts low to nonexistent if suggested mitigation were implemented. If the airstrip were open to all users, impacts would increase to low to moderate.

4.9 Wildlife

Mine area. Direct habitat loss, and direct impacts to birds and mammals, high only on a local mine site basis. No high indirect impacts on birds. Moose, brown bears, and marten could experience indirect impacts, but high only on a local mine site basis. Minor disruption of large mammal movements because of mine site facilities. Possibility of occasional entrapment in the RPT. If garbage not handled properly, bears likely would have to be killed.

Gravel source. Mining gravel, rather than crushing development rock, would cause surface disturbance to an additional approximately 66 acres on the Goodpaster Valley floor. Disturbance generally would be to lower value habitat. And, if the gravel pits were reclaimed as ponds, habitat benefits would accrue. Still, mining gravel would have a moderate local overall habitat impact compared to crushing development rock for gravel.

Air access. Airstrip removal at mine closure would allow relatively high value habitat to begin recovery. Airstrip removal also would eliminate continuing indirect habitat impacts from human activities.

4.10 Threatened and Endangered Species

No impacts on threatened or endangered species. High impacts to sensitive species only on a local basis.

4.11 Socioeconomics

Air access. If airstrip were open to other industrial/commercial users, or to everyone, it could provide some additional industrial/commercial development and create some new economic activity, population growth, and demand for public services. Removal and reclamation would eliminate this potential.

4.12 Land Use

Air access. Closing airstrip to everyone except the Pogo project could have a major impact on potential commercial and industrial activities, such as mining. Allowing other commercial/industrial users to access the airstrip could provide new service support options, as well as fly-in recreational services. Removing and reclaiming airstrip could have a major impact on commercial air operators, recreationists, and potential new mineral development in the area.

4.13 Subsistence

Mine area. Impacts low except in the immediate mine area where subsistence users would be prohibited from hunting for public safety purposes. This area is small in context of the overall subsistence use areas. Lack of availability of the mine site for subsistence hunting would not affect the overall pattern of subsistence use because other areas are available. It would be more a reduction in opportunity to hunt in a traditional place that was used by one's relatives and ancestors.

Table A-1 Summary of Direct and Indirect Effects of the Options Common to All Alternatives

Fuel storage. If contamination were to cause fish damage, decline, displacement, or contamination, it would affect availability to subsistence fishers. Also, just concerns about contamination could lead to reduced fish consumption because of fear of contaminated resources. Depending on duration and severity, contamination could have a moderate effect on subsistence fishing uses. Although there are substantial other areas available for subsistence fishing and the overall pattern of subsistence uses would not be seriously jeopardized in such an event, the Goodpaster River is a currently used and highly regarded river by descendents and related kin of Athabaskans who used this area traditionally.

Air access. Airstrip open only to Pogo project use during mine operations, and removal and reclamation at the end of mine operations, would have low impacts. Conversely, airstrip open to everyone during and after mine operations would have moderate to high subsistence impacts.

4.14 Cultural Resources

Because adherence to cultural-resource protection procedures under CFR 800, Section 106, are the accepted process by which to mitigate impacts to cultural resources, no high impacts to cultural resources are expected.

4.15 Visual

Tailings dry stack. Airborne view impacts would be high. Because of vegetation screening, visual impacts from the Goodpaster River would be low.

Mill and camp. Goodpaster River recreationists would have obscured foreground and middle ground views, and visual impacts would be low. Airborne viewers would have obscured views due to the valley's slope and topography, but impacts could be somewhat higher to viewers desiring a totally primitive experience.

Air access. If airstrip open to everyone during and after mine operations, backcountry users desiring a nonmotorized experience would see greater aircraft activity, as well as seeing more recreational users,

4.16 Recreation

Air access. If airstrip open to everyone during and after mine operations, it would be a major benefit to prospective recreational users, particularly those desiring to hunt, fish, or float the Goodpaster River. This increased recreation access would have a low effect on existing recreational users because there is presently little recreational use. Recreational cabin owners on the lower Goodpaster River, however, could be affected moderately by floaters and fishermen who would float into the lower river past these cabins. This increased use of the river would alter their present isolation and could cause changes in fishing bag and size limits, as well as an increase in littering and vandalism.

4.17 Safety

Impacts would be low.

4.18 Technical and Economic Feasibility

Mining gravel versus crushing development rock. Gravel is on the critical path for project construction. It would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option. Most of the nonmineralized rock that would be generated from underground would not be available until later in the two-year project development period. Underground mine development must follow completion of the appropriate surface facilities described above. Advancing underground development before beginning the surface civil works isn't possible because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable.

From another perspective, experience during the Pogo Mine exploration phase has demonstrated that underground development rock does not make a good traffic surface for high volume roads. At the existing advanced exploration facilities, gravel has been used to top the surface of the high volume roads because the development rock breaks down under traffic loads and becomes mud. Thus, from a technical perspective, crushing development rock to make gravel would not be feasible or practicable. Also, a gravel road topping has helped to reduce sedimentation both on the surface and underground, where reduced sedimentation in the mine sumps has been an important factor in water treatment plant efficiency.

Another need for gravel may arise for topping portions of the mine access road. Test work at potential material sites along the proposed Shaw Creek Hillside road

Table A-1 Summary of Direct and Indirect Effects of the Options Common to All Alternatives

alignment has shown the rock in most of the proposed material sites does not conform to ATM T-13 degradation, or to Los Angeles Abrasion ASTM C131-96 specification for coarse abrasion testing of coarse rock. Thus, while the rock from these sites would still be suitable for bulk fill, topping material with sufficient hardness for the road surface would have to be hauled long distances from select material sites. Two of the material sites may contain rock suitable for crushing and use for road topping, and it would be advantageous in some areas for the Applicant to do so rather than haul gravel from the vicinity of the mine. Some of the gravel from the mine area sites, however, could be used for access road topping.

Even if nonmineralized development rock were suitable for crushing, which it is not, the direct cost to produce approximately 140,000 cu yd of aggregate for use in the mine area would be approximately three to four times greater than mining pit run gravel by expanding existing borrow pits and developing new ones as proposed by the Applicant. A reasonable cost estimate for pit run gravel at the Pogo site is approximately $4 per cu yd. Thus, crushed development rock would cost between approximately $1.1 million and $1.7 million more than mined gravel (Rowley, 2002a).

Mining gravel from existing and new pits versus crushing nonmineralized development rock for gravel would disturb approximately 66 more acres. As discussed later, the off-river treatment works was selected as the preferred option for the industrial wastewater discharge component. Because this option would require excavation of approximately 13.1 acres of gravel to create the two ponds, a portion of the overall project's required mine area gravel needs would be met during excavation of the ponds, and the 66-acre total would be reduced to approximately 53 acres. A portion of this disturbance would be to wetlands, and would have moderate impacts. But those impacts would be offset by pond creation in the gravel pits, resulting in negligible overall wetlands impact. Mining gravel would have a moderate local wildlife habitat impact although this, too, would be mitigated somewhat by pond formation. Still, surface mining of gravel would account for approximately 7 percent of the total surface disturbance for the Applicant's Proposed Project.

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
4.1 Surface Water Hydrology		
Unlined tailings facilities. No effect on surface hydrology. Wastewater discharge. Injection of excess water into wells could raise water levels in adjacent sloughs by 2 feet. Overall impacts are expected to be low.	Wastewater discharge. Direct discharge of excess water to the Goodpaster River would increase flow in river. Managing discharge flows to a ratio of 45:1 (river: discharge) would limit flow increase to approximately two percent. This managed discharge would have a low impact.	Wastewater discharge. Discharge via an off-river treatment works would reduce flow in an 1800-foot stretch of the Goodpaster, but a flow of at least 20 cubic feet per second would be maintained at all times in this stretch. Even during normal annual winter low-flow conditions in the river, there would be enough water to meet wastewater mixing discharge requirements. Downstream of re-entry channel impacts would be the same as for Alternative 2.
4.2 Groundwater Hydrology		
Unlined tailings facilities. Low effect on groundwater hydrology. Wastewater discharge. Injection of excess water into wells or the SAS could raise groundwater elevations locally by up to several feet. Overall impacts are expected to be low.	There would be no groundwater impacts.	Same as Alternative 3.
4.3 Water Quality		
Unlined tailings facilities. Low effect on water quality. Wastewater discharge. Projected quality of the water to be discharged from the SAS during operations would not meet discharge criteria for a number of parameters. The inability to meet discharge criteria was considered as having a high impact from a permitting and compliance perspective, and may not be permittable.	Wastewater discharge. Direct discharge to the Goodpaster River with a mixing zone during development and operations would result in low impacts on water quality. The discharge is expected to meet all criteria for all parameters. It is uncertain, however, whether mercury would bioaccumulate to high adverse levels from this discharge; hence, it is uncertain whether a mixing zone could be granted.	On-site power generation. This option would have a moderate to high potential to affect water quality due to approximately 4.2 million gallons of fuel to be transported to the mine site annually. A major spill could cause a high impact over a large watershed area Wastewater discharge. Discharge to the Goodpaster River via an off-river treatment works during operations would result in low impacts to water quality. The discharge is expected to meet all criteria for all parameters. At 400 gpm residence time would be approximately 24 hours, which would provide ample time to respond to potential upset conditions at the water treatment plant.
4.4 Air Quality		
Power line. Low impact in the vicinity of the existing permitted power generation source near Fairbanks.	Power line. Same as Alternative 2.	On-site power generation. Low impacts on local air quality under permit conditions.

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
4.5 Noise		
There would be no or low impacts.	Same as Alternative 2.	On-site power generation. Generators would use noise reducing equipment to meet Occupational Safety and Health Administration standards, and would not cause a major addition to the noise levels projected for options common to all alternatives (Table A-1).
4.6 Wetlands		
Power line. Would require clearing and slightly disturbing ground surface of approximately 119 or 158 acres of wetlands and other water bodies, depending on route. Wastewater discharge. Minor soil absorption system impacts at either the airstrip or above Pogo Ridge, but the latter would have greater wetlands acreage impacts. Injection wells. Could have the capacity to increase the groundwater table level, flood swales and otherwise dry sloughs, and create small, scattered, wetland-like areas. There likely would be sporadic, and ephemeral, and wetland benefits would be small.	Power line. Same as Alternative 2. Wastewater discharge. No or low impacts from direct discharge to Goodpaster River.	On-site power generation. Would require transport and storage of ~ 4.2 million gallons of diesel fuel annually, substantially increasing risk spills into wetlands. Also more road traffic, resulting in increase in dust and sediment-laden road runoff into wetlands. Impact would be minor because of low risk of a substantial spill. Wastewater discharge. Off-river treatment works would have no additional wetland effects beyond those for the gravel pits because it would be constructed in the excavated pits.
4.7 Surface Disturbance		
Power line. 602 or 525 acres of clearing depending on route. Wastewater discharge. 4.4 acres for the SAS.	Power line. Same as Alternative 2. Wastewater discharge. 0.5 acres for direct discharge to Goodpaster River.	On-site power generation. ~ 22.7 acres for extra fuel storage (6.1 acres) and laydown area (16.6 acres) to accommodate winter-only access need to store a full year's fuel and supplies. Wastewater discharge. 13.1 acres, but would be constructed in already excavated gravel pits.
4.8 Fish and Aquatic Habitat		
SAS. Depending on where the ground water would reach the river, overall impacts to the river's aquatic resources in the long term would be low to moderate, and would be localized.	Direct discharge to Goodpaster. This option would have a high impact on aquatic resources in the immediate vicinity of the diffuser pipe, and a low impact outside the mixing zone during normal operations. Process upsets and facility failure could cause	On-site power generation. This option would substantially increase risk of accidents during fuel transport and storage that could have moderate to high local impacts, and high impacts to the chinook population if an accident occurred during low winter flows or spawning.

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
	impacts. Because the probable frequency of these events is low, and the dilution factor high, the impacts would be moderate and localized.	Off-river treatment works. This option would have fewer impacts than the other discharge options. Process failures, mine shutdowns, and environmental upsets could be better addressed with this option considering its storage capability. Because of the low probability of the combination of upset events that would exceed this capability, and the unknown effects of severe winter weather on the process facilities, impacts would be low to moderate, and localized. A minimum flow of 20 cubic feet per second would be maintained in the Goodpaster River at all times to provide sufficient flow for fish.
4.9 Wildlife		
Power line. Would require clearing vegetation on approximately 602 or 525 acres, depending on the route. Clearing generally would not destroy vegetative mat. Altered habitat would still provide support to wildlife, though of a different species composition. Habitat impacts, and indirect impacts to birds and mammals, would be high only on a local basis. Birds would experience direct impacts from collisions, but these are expected to be high only on a local basis. Browsing mammals would benefit from the edge effect created by clearing the ROW. This benefit would be of importance only on a local basis. SAS and underground injection. SAS surface disturbance to 4.4 acres would be moderate only on local basis.	Power line. Same as Alternative 2. Direct discharge to Goodpaster. This would have a low impact.	On-site power generation. This option would require an additional ~22.7 acres of surface disturbance for increased diesel fuel storage and laydown area versus clearing vegetation on approximately 602 or 525 acres for a power line, depending on the route. Loss of ~ 2.7 acres would be moderate and only on a local basis. This option would require ~4.2 million gallons of fuel to be transported to the mine site annually. This transportation of fuel would pose a greater impact risk to wildlife and habitat from spills than would the power line option clearing. There would be only very local high direct or indirect impacts to birds or mammals from this option. Water discharge. Off-river treatment works would have few additional effects beyond those for the gravel pits because it would be constructed in the excavated pits.
4.10 Threatened and Endangered Species		
Power line. There would be no impacts on threatened or endangered species. For sensitive species, ROW clearing could cause loss of some raptor nest sites,	Power line. Same as Alternative 2.	On-site power generation. There would be no impacts on threatened or endangered species. There would be no power line ROW

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
depending on the route. Because portions of both routes would traverse forested habitats, there would be a collision risk for Northern Goshawks.		clearing impacts. Risks from fuel spills from substantial additional fuel transport would be the same as discussed above for wildlife.
4.11 Socioeconomics		
Power line. Greater long-term potential for supporting additional industrial/commercial activity, allowing mine developers or others to enjoy a substantial construction and operation cost savings compared to constructing a new power line or providing on-site generating capacity.	Power line. Same as Alternative 2.	On-site power generation. Would not provide the greater long-term potential for supporting additional industrial/commercial activities as would a power line.
4.12 Land Use		
Power line. Would benefit potential new commercial and industrial land uses.	Power line. Same as Alternative 2.	On-site power generation. This option could have a high impact on potential commercial and industrial users because mineral development could be slower without a power line to Pogo. Such development would need to haul fuel for on-site generation, or construct a power line.
4.13 Subsistence		
Power line. ROW clearing would create an access corridor for recreational as well as subsistence users, and could increase competition for subsistence resources. Mitigation measures could limit ROW access to some extent. If road use were open to everyone, however, the power line ROW would offer little advantage because it would follow closely the road alignment.	Power line. Same as Alternative 2. Direct discharge to Goodpaster. If this option were to cause impacts on fish and aquatic habitat from process upsets, facility failures, or bioaccumulation, it could lead to the same impacts on subsistence fisheries downstream as described for fuel storage in Table **A-1** (Options Common to all Alternatives).	On-site power generation. This option would require greater on-site fuel storage, and surface movement of approximately 4.2 million gallons of fuel annually. Fuel storage and transportation would substantially increase the risk of fuel spills at stream crossings and from transfers between tankers and storage tanks, raising the same concerns for downstream impacts to fish, fish habitat, and subsistence fisheries as described in Table A-1. Off-river treatment works. Same as Alternative 3. This option would have the capacity to provide up to 24 hours of holding time in case of upset conditions at the water treatment plant.
4.14 Cultural Resources		
Because adherence to cultural-resource protection procedures under CFR 800, Section 106, are the accepted process by which to mitigate impacts to cultural resources, no major impacts to cultural resources are expected.	Same as Alternative 2.	Same as Alternative 2.

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
4.15 Visual		
Power line. High visual impacts because of the scale, distance, and viewer recognition of power poles compared to on-site power generation.	Power line. Same as Alternative 2.	On-site power generation. This option would require additional 22.7 acres for fuel storage and laydown area at the airstrip. This use of additional acreage would have a low impact on views of recreationists on the Goodpaster River. Impacts would be very substantially less than for a power line.
4.16 Recreation		
Power line. Without mitigation the cleared ROW would provide backcountry access for both motorized and nonmotorized recreational users. This increased access would be high for existing and new recreational users. If road use open to everyone, however, power line ROW clearing would offer little advantage because it closely follows road alignment.	Power line. Same as Alternative 2.	On-site power generation. This option would cause a small increase in noise and other activity in the vicinity of the mine and access route due to the generators and the additional fuel transportation. This disturbance would have a low to moderate impact on primitive and semi-primitive motorized recreational opportunity spectrum (ROS) classes.
4.17 Safety		
Impacts would be low.	Same as Alternative 2.	Same as Alternative 2.
4.18 Technical and Economic Feasibility		
Tailings dry-stack liner. Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability perspective, however, a liner would be more problematic. The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk.	Same as Alternative 2.	Same as Alternative 2.

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
Overall, there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner. Installation of an erosion control/drainage blanket before tailings would be placed in the dry-stack tailings facility was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation. RTP liner. The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities. Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cut-off wall. The proposed RTP dam face liner system and grout curtain would establish an effective interception cut-off wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock. ▪ A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including: ▪ A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cut-off wall required to collect the subsurface seepage. If such a cut-off wall at		

Table A-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Surface Access Related

Alternative 2	Alternative 3	Alternative 4
the upgradient end of the liner were required, it would follow that another liner upstream of that cut-off wall also would be needed, etc. It is thus a cut-off wall perpendicular to the flow that would be needed to capture seepage, not a liner. ▪ Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume. The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V). A full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage. From the economic perspective, if a liner were feasible, a very rough estimate for the cost of a full basin liner under the RPT is approximately $1.5 million.		

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
4.1 Surface Water Hydrology		
Shaw Creek Hillside all-season road. During and immediately following construction, modifications to surface water hydrology could occur due to increased runoff volumes caused by vegetation removal and soil compaction. Increased flows could be mitigated by using stormwater runoff BMPs.	South Ridge all-season road. Same as Alternative 2.	Winter-only access. Same as Alternative 2, except for the tendency of ice roads to thaw later than surrounding areas, raising potential for blockage or rerouting of runoff flows during breakup. These effects would be localized and temporary.
4.2 Groundwater Hydrology		
No groundwater flow impacts were identified.	Same as Alternative 2.	Same as Alternative 2.
4.3 Water Quality		
Shaw Creek Hillside all-season road. Primary potential impact to water quality would be from a fuel or chemical spill during transport to the mine site. The likelihood of a major release would be low, but the potential impact from a large spill into surface waters would be high. The overall water quality impact of fuel and commodity transport by this access route would be moderate. Road use and disposition. Use by the Pogo project only would have the lowest potential for accidents and subsequent releases. With increased usage, the potential for a release would increase. Continued use after mine closure would cause spill risks to persist.	South Ridge all-season road. The likelihood of a major spill would be moderate, because of the more exposed conditions, ice, higher winds, and greater potential for whiteout conditions in winter. But, potential for an individual spill to affect a water body would be lower because of fewer wetlands and the road distance from active drainages. Overall water quality impact of commodity transport by this access route would be moderate. Road use and disposition. Same as Alternative 2.	Winter-only access. Because of the intense use of the road under difficult winter driving conditions, and the route's initial alignment through more wetlands, this option would have a high potential to impact water quality. Road use and disposition. Same as Alternative 2.
4.4 Air Quality		
Shaw Creek Hillside all-season road. No or low impacts. Small fugitive dust impact on adjacent vegetation. Road use. Restricting use of the road during Pogo operation would limit fugitive dust proportionally. Road disposition. If maintained, restricting use would limit fugitive dust proportionally. If removed and reclaimed, it would eliminate low fugitive dust impacts.	South Ridge all-season road. Same as Alternative 2. Road use. Same as Alternative 2. Road disposition. Same as Alternative 2.	Winter-only access. Seasonal use of the winter-only access segment would eliminate fugitive dust impacts in lower Shaw Creek Valley, and reduce them on the all-season road segment because it would be used only in winter.
4.5 Noise		
Shaw Creek Hillside all-season road. No major impacts were	South Ridge all-season road. No	Winter-only access. There would be no major noise

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
identified. Shaw Creek Road egress. Pogo-related impacts to Shaw Creek Road area residences would be low or moderate, with one exception that would be moderate to high. If the Applicant's shift-change bus station were near the TAPS crossing, two residences would experience a moderate to high impact and four would experience a high impact. If the bus station were located on the Richardson Highway, one residences would experience a moderate impact, three a moderate to high impact, and one a high impact. Road use and disposition. Additional traffic noise from allowing everyone to use the road during and after Pogo operations would cause only a small increase in impacts above the Pogo-related level, but would approach a high impact for one residence. Of the disposal options, only removal and reclamation would reduce impacts in a meaningful way.	major noise impacts on residents in the Quartz Lake and lower Goodpaster River areas were identified. Road use and disposition. Same as Alternative 2.	impacts.
4.6 Wetlands		
Road/power line surface disturbance. All-season road and power line would cut and fill ~120 acres and clear ~158 acres of wetlands, for a total of ~278 acres. Shaw Creek Hillside all-season road. Impacts would be high within each wetland complex through which the road passed, but would be dispersed along 49-mile route and focused on flat wetlands, which are the least valuable wetland type. Effects would be minor in the context of the Shaw Creek and Goodpaster drainages. Shaw Creek/Rosa egress. No impacts. Tenderfoot egress. No impacts. Road use. Use only by Pogo or other industrial or commercial users would cause minor impacts in context of Shaw and Goodpaster drainages. Use by everyone, particularly unregulated ATVs, would cause moderate impacts. Road disposition. Continued use only by industrial or commercial users would cause minor impacts. Use by everyone would cause high impacts in certain localities, but moderate within context of Shaw and Goodpaster drainages. Security gate at Gilles Creek. Same impacts as use by	Road/power line surface disturbance. All-season road and power line would cut and fill ~75 acres and clear ~119 acres of wetlands, for a total of ~194 acres. This would be ~84 fewer acres than Alternatives 2, with ~45 of the acres with less cut and fill. South Ridge all-season road. Same as Alternative 2. Road use. Same as Alternative 2, except road use by everyone would cause only minor impacts because less off-road ATV use in wetlands is expected. Road disposition. Same as Alternative 2, except road use by everyone would cause only minor impacts because less off-road ATV use in wetlands is expected. Power line. Same as Alternative 2.	Road surface disturbance. The winter-only access segment and all-season road segment, with no power line, would cut and fill ~103 acres and clear ~50 acres of wetlands, for a total of ~153 acres. This affected acreage would be ~125 and ~41 fewer acres than Alternatives 2 and 3 (including their power lines), respectively. Road/power line surface disturbance. Although Alternative 4 by definition has on-site power generation, the winter-only access option could be paired with a power line as the Preferred Alternative. In that case, the road and power line combined would cut and fill ~135 acres and clear ~211 acres of wetlands, for a total of ~ 346 acres. This affected acreage would be ~ 68 and ~152 more acres than Alternatives 2 and 3 (including their power lines), respectively. Winter road/trail construction standards. Under the traditional winter road option, a higher percentage of wetlands would only be cleared down to the organic mat, and would remain wetlands and retain their

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-Only Access)
everyone, but moderate impacts would be limited to area west of Gilles Creek. Power line. Would affect extensive area by clearing, but effects would be only minor because: most wetland functions would remain undisturbed or be affected to minor degree; disturbance would be primarily to lower value wetlands; and disturbed areas would be a minimal proportion of project area wetland resource. Sutton Creek. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the Shaw Creek / Goodpaster divide rather than up Sutton Creek. Wetlands disturbance in the Sutton Creek segment would total approximately 4 acs. Because the boundaries between wetlands and uplands are more distinct along this route, the power line likely could be sited to avoid some of these wetlands. Wetlands disturbance if the power line were routed adjacent to the road over the divide would total approximately 6 acres. Because the power line would traverse primarily mosaics of wetlands/uplands along this route, wetlands would be more difficult to avoid. While fewer wetlands would be affected by the Sutton Creek route, the absolute difference would be small, and following the road route over the divide would remove all wetlands impacts from the Sutton Creek drainage.		functions. The perennial winter trail option, however, would cut or fill 24 more acres than the traditional winter road option because its construction method would cut the ground surface. Road use. By its seasonal nature, this alternative would be less likely to promote additional development and cause wetlands impacts in the Shaw Creek, Goodpaster, and adjacent drainages. Once the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek, however, impacts from road use would be the same as Alternative 2
4.7 Surface Disturbance		
Surface access. 770 acres for Shaw Creek Hillside route with Shaw Creek/Rosa egress option. 43 more acres with Tenderfoot egress option (total 813 acres). Power line. 602 acres for Shaw Creek Hillside route.	Surface access. 768 acres for South Ridge route. Power line. 525 acres for South Ridge route.	Surface access. 594 acres for Shaw Creek Flats winter-only access route. Power line. If a power line were paired with winter-only access, 600 acres would be cleared for the Shaw Creek Hillside route.
4.8 Fish and Aquatic Habitat		
Shaw Creek Hillside all-season road. Impacts none to low. Road use. If open to everyone, overall impacts low to moderate due to traffic volume and recreational activities. Boating in low flows on Goodpaster could disrupt spawning behavior and dislodge and suffocate eggs. Exhaust emissions	South Ridge all-season road. Same as Alternative 2, except even fewer impacts because only one stream crossing (Goodpaster River) and would completely avoid the Shaw	Winter-only access. Impacts would be higher than Alternatives 2 and 3 due to risk of accidents during the short winter transportation window, especially fuel spills, at or near stream crossings under severe winter conditions, and particularly on the steep divide between

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-Only Access)
pollute water and could disturb riparian habitat by undercutting banks through wake action. Increase in number of boats on the Goodpaster. Road disposition. Maintaining road open to everyone would have same impacts as for road use. Security gate location. Same impacts as for road use by everyone, except impacts would only occur in lower Shaw Creek Valley. Would eliminate impacts from angling and boating on the Goodpaster.	Creek drainage. Road use. Same as Alternative 2. Road disposition. Would differ from Alternative 2 because with no stream crossings other than the Goodpaster, removal and reclamation would still allow ATV access to the Goodpaster via cleared ROW for some time following reclamation. Such access likely would result in erosion problems as shown by historical ATV use.	Shaw Creek and Goodpaster drainages. An accident near the upper Shaw Creek or Goodpaster crossings could cause high impacts to overwintering fish during low flows of winter. Road use. This option initially would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as Alternative 2 unless public use were restricted.

Table A-3 Summary of Direct and Indirect Effects of <u>Surface Access Related</u> Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
4.9 Wildlife		
<u>Shaw Creek Hillside all-season road and power line.</u> <u>Habitat</u>. Because the 1,372 combined acres of disturbance: would be linear in nature; have low or no impacts on rarer or uncommon habitat classes; are well represented within project area and interior Alaska; would affect few Conservation Priority Index lands; and have small impacts on high value habitat for large mammals, habitat loss would not be high. Also, the approximately 602 acres within the power line ROW would only be cleared of vegetation, with little actual surface disturbance. <u>Birds</u>. Primary direct impacts from collisions, with impacts high only on a local basis. There would be no major indirect impacts. <u>Mammals</u>. Primary direct impacts from vehicle collisions, particularly in winter. This mortality would be low. If road open for everyone, this mortality could be moderate only on a local basis. Indirect impacts would be low for most species. Brown bears and wolverines likely would avoid the road corridor other than for crossing. This avoidance would not cause major habitat fragmentation for these species. For marten, however, the road corridor likely would serve as more of an indirect behavioural barrier to movements and could cause some habitat fragmentation. <u>Security gate at Gilles Creek</u>. Impacts would be similar to those described above, but limited to lower two-thirds of Shaw Creek Valley. This reduction of public use would lower collision mortality. <u>Power line route</u>. The sub-option of following the road corridor over the Shaw Creek / Goodpaster divide, rather than separately up Sutton Creek, would have approximately the same habitat impact, but by consolidating the two corridors, as occurs for the large majority of the remainder of this alternative's route, it would remove all wildlife impacts from Sutton Creek with minimal additional impacts adjacent to the road.	<u>South Ridge all-season road and power line</u>. <u>Habitat</u>. Approximately 1,293 combined acres of disturbance would occur. Habitat impacts would be similar to Alternative 2, and would not be major. This alternative, however, would disturb roughly twice the acreage of high value habitats for moose, caribou, and brown bear than would Alternative 2. <u>Birds</u>. Direct and indirect impacts on birds would be the same as Alternative 2, except that bird-power line collisions likely would be higher because for approximately 25 miles it would be above timberline along the South Ridge. <u>Mammals</u>. Indirect impacts generally would be the same as Alternative 2. This alternative, however, would avoid the moose rutting area in Shaw Creek Valley, and its long run above timberline along the Shaw Creek and Goodpaster divide would not pose the same habitat fragmentation concern for marten as would Alternative 2.	<u>Winter-only access.</u> <u>Habitat</u>. Approximately 594 acres of disturbance would occur. Habitat impacts would be similar to Alternative 2, and would not be high. This alternative, however, would disturb only approximately 37 acres of high-value Conservation Priority Index lands in lower Shaw Creek Valley versus approximately 85 acres for Alternative 2. This alternative also would disturb approximately 54 percent less high value habitat than would Alternative 2. <u>Birds</u>. Direct and indirect impacts would be the same as for Alternative 2. <u>Mammals</u>. Direct impacts from collisions would more likely to occur than for Alternative 2 because of substantially greater winter traffic. These impacts would be locally low to moderate, depending on the particular winter. Indirect impacts would be similar to Alternative 2, but would be very small for approximately 9 months of the year. During the annual winter use period, however, vehicle noise and activity levels would be very high. This noise and activity would cause disturbance to moose, and caribou if they were in the vicinity, at a critical time (middle and late winter) when energy reserves are low. <u>Road use</u>. Would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2 unless public use were restricted.

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
4.10 Threatened and Endangered Species		
Shaw Creek Hillside all-season road. No impacts on threatened or endangered species. Sensitive species impacts would be low. Power line. Route would be in close proximity to three recently active Northern Goshawk nests, but would cross relatively little high-value goshawk habitat.	South Ridge all-season road. Same as Alternative 2. Power line. Route in close proximity to only one recently active Northern Goshawk nest, but would cross substantially more high value goshawk habitat.	Winter-only access. There would be no impacts on threatened or endangered species. Impacts on sensitive species would be low.
4.11 Socioeconomics		
Shaw Creek Hillside all-season road. More employees could reside in Delta area because work periods would be shorter and employees would be bused. Between ~100 and 135 of mine's 385 workers would live in Delta area and create another 30 to 40 jobs in local economy. Mine-related population would be between ~260 and 350 and have a substantial and positive local effect. Annual mine-related payroll in the Delta area would be between ~$7.2 million and $9.4 million. Effects on the local school system likely would be low, with a slight increase in demand for other public services. Effects on the housing market would be high, and generally positive. Road use and disposition. If open to industrial and commercial users, the road would increase access for other development, creating additional economic activity, population growth, and demand for public services. If open for everyone, the road would create more economic activity. In either case, local effects likely would be low.	South Ridge all-season road. Same as Alternative 2.	Winter-only access. Employees would work longer periods, have longer off-work periods, and be flown to and from site, allowing them to live more distant. Between ~40 and 80 workers would live in Delta area and create another 10 to 15 jobs in local economy. Mine-related population would be between ~100 and 190 and have a major and positive local effect. Annual mine-related payroll in the Delta area would be between ~$2.8 million and $5.7 million. Other effects would be the same as Alternative 2.
4.12 Land Use		
Shaw Creek Hillside all-season road. Land use impacts would be low because all uses would be compatible with adopted land use plans. Existing land uses, however, could be substantially *changed*. Richardson Hwy. Egress. Shaw Creek/Rosa option would substantially increase existing use of Shaw Creek Road, while Tenderfoot option would substantially *change* existing land use. Shaw Creek and Richardson Highway areas generally	South Ridge all-season road. Impacts would be similar to those for Alternative 2, except that the impacts to existing residential and other users near the Richardson Highway would occur in the vicinity of the highway near Quartz Lake rather than in Shaw Creek area.	Winter-only access. Impacts similar to those for Alternative 2, except as noted below. Road use. Access not as beneficial to potential commercial/industrial users. New development likely would be slower to develop than with an all-season road. If open to the public, because of its seasonal nature, it would be a benefit to existing residential and recreational users in the Shaw Creek and Goodpaster

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
would experience some increase in residential use and development with either option. Road use. Access could substantially benefit new commercial and industrial users. If open to public, it would provide access to large presently remote areas. Road disposition. Reclaiming the road could be a substantial impact to new commercial/industrial land uses that occurred because of initial road construction, but existing land uses along Shaw Creek Road would not be substantially affected. If open to the public during project operation, reclaiming would be substantial impact to new recreational users, and any service businesses that developed to support new backcountry users. Security gate location. Limiting public access to south of Gilles Creek would substantially reduce likely changes to existing land uses beyond Gilles Creek. DOF road. This road would not be built if the Shaw Creek Hillside all-season road were constructed.	DOF road. Planned road into the Indian Creek area could cause moderate *changes* in land use (e.g., timber harvesting in presently uncut areas), but harvests would be compatible with existing land use plans.	valleys, including the Goodpaster cabin owners, because users would be able to access the upper reaches of the Shaw Creek and Goodpaster drainages only in winter, which they largely can do now. Trappers, commercial sled dog tour operators, and other backcountry users also would consider winter-only access less of an impact. Potential recreational users, however, would not have increased access to more remote areas during the 9 months when the perennial winter trail would be impassable. DOF road. If the winter-only access option were constructed, the DOF forestry road would be built and eventually would connect with the southern end of the all-season road segment of this winter-only access option. Because the DOF road would be open for public use, all impacts discussed in Alternative 2 likely would occur at least to the point south of Gilles Creek where the roads would connect.
4.13 Subsistence		
Shaw Creek Hillside all-season road. Road itself would have a low effect on the availability of subsistence resources. Road use and disposition. Least access into Shaw Creek and upper Goodpaster River drainages would have fewest impacts. Use by everyone would open inaccessible areas to the general public. If sport hunters and other recreationists were able to cross the Goodpaster River, it could ease problems of reaching high country north and northeast of Healy Lake. It would create substantially increased access and competition for a long time period over a potentially large geographic area. This impact would be major within the local and regional context for present-day subsistence hunters. Recent subsistence use areas, however, are substantially larger than the immediate area of the all-season road. Traditional users may avoid the area because of the road and traffic. Thus, the road has potential to be regarded as a loss of a part of one's homeland for hunting, not necessarily the	South Ridge all-season road. Same as Alternative 2, except that subsistence use patterns along the South Ridge route are slightly different.	Winter-only access. Would not allow all-season road access to upper Shaw Creek and the mid-Goodpaster River Valley, thus substantially limiting potential subsistence impacts from increased recreational and other subsistence users. The Shaw Creek Flats portion of the route would cross wetlands and recent and traditional subsistence use areas. Any fuel or cyanide accidents on the flats resulting in resource damage, decline, displacement, or contamination would affect availability to subsistence users, and contamination concerns could lead to reduced resource consumption and years of wondering if the resources from the area as well as "downstream" were safe to eat. Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, subsistence impacts from public use would begin to approach those

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-Only Access)
primary or most used hunting area, but one that was historically and is currently used. Security gate location. Would limit impacts to lower Shaw Creek Valley. Richardson highway egress. Little difference in effects between Tenderfoot and existing Shaw Creek Road options. Power line. Little or no additional impacts to those of road.		described for Alternative 2,
4.14 Cultural Resources		
Shaw Creek Hillside all-season road. Because adherence to cultural resource protection procedures under CFR 800, Section 106, are the accepted process by which to mitigate impacts to cultural resources, no major impacts to cultural resources are expected from direct project development. Road use and disposition. Additional road users would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage.	South Ridge all-season road. Same as Alternative 2.	Winter-only access. Same as Alternative 2, except limited seasonal access would decrease human presence considerably and surface artifacts and other cultural resources would be less vulnerable to looting and other types of damage.
4.15 Visual		
Shaw Creek Hillside all-season road and power line. Routes would be along lower elevations of the hillside and would have low impacts as viewed from Richardson Highway. They still would be evident to backcountry users and airborne viewers. Impacts would be high to some Shaw Creek Road residents because of the close viewing distance and the substantial contrast to the natural landforms of the hillside. The Goodpaster River Bridge, and the power line, would have high visual impacts to viewers on the river near the mine site. Richardson highway Egress. Tenderfoot egress option is located in a low visual absorption capability area. Development of this option would have moderate to high impacts on the visual resources because of high viewer sensitivity. There would be no impacts with the Shaw Creek Road/Rosa option. Road use. Impacts would be low from use only by Pogo-related traffic. If other users, there would be greater disturbances (light and dust) potentially viewable for longer periods. There also would be an increase in vehicle lights	South Ridge all-season road and power line. More visible higher elevations along this route would have moderate to high impacts due to the low visual absorption capability and the sensitivity of viewers. Impacts would be considered high to Goodpaster River cabin owners and Goodpaster River Winter Trail users. Road corridor would not be visible from Quartz Lake; however, the power line would be somewhat visible from the lake at a distance of ~2 miles. Road use. Because this alternative would have higher visual impacts than Alternative 2, use by others than the Pogo project would have correspondingly greater impacts than Alternative 2.	Winter-only access. The Shaw Creek Flats route would not be visible from the Richardson Highway because of the low elevation of the flats and its high visual absorption capability. Overall impacts would be low. Road Use. Use by other than the Pogo project would have low visual impacts because of the nature of a winter-only access and its limited window of operations. Road disposition. Impacts for the all-season road segment would be the same as Alternative 2. The Shaw Creek Flats winter-only access segment simply would not be used again for Pogo purposes and would be available for use by anyone, much as a majority of the route is today.

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
during periods of low natural daylight, particularly in winter. Road disposition. Removal of road and power line would have fewest impacts on visual resources. Current visual appearance would be restored as vegetation reclaimed the corridor. Other options would have an increasing impact in ascending order of industrial/commercial users and open to everyone.	Road disposition. Same as for Alternative 2, except that because the visual impacts of this alternative would be greater, they would remain longer before vegetation obscured them.	
4.16 Recreation		
Richardson Highway Egress. The Shaw Creek/Rosa option would have low impacts on existing or prospective recreation users. Tenderfoot would have a high positive effect on potential recreational users because route presently is undeveloped. Road use and disposition. Use by Pogo and other industrial or commercial users only, and removal and reclamation, would have a high impact on prospective motorized recreational users, but would have a low impact on existing recreational users. Permanent access for everyone would have a high impact on existing recreational users desiring remote recreational experiences. The Goodpaster Bridge could become a popular launching site for floaters and fishers and bring them into the lower river and past these cabins. This could change the present relative isolation of the cabins, and could cause changes in fishing bag and size limits, and an increase in littering and vandalism. Security gate location. Same impacts as use by everyone, except impacts would occur only lower Shaw Creek Valley. Impacts to Goodpaster recreational cabin owners and other existing recreational users north of Gilles Creek would not occur. Potential recreational users, however, would not receive the benefits of easy access to the mid-Goodpaster River	Road use and disposition. Same as Alternative 2, except there would be somewhat more impacts on the Goodpaster Valley recreational cabin owners because parts of the access road would be visible from the cabins.	Winter-only access. Road use. If use limited to Pogo-related traffic, or other industrial/commercial users, it would lower the quality of existing nonmotorized recreational experiences, but this would be limited to the area of the road corridor. Because this alternative would reduce new recreational motorized vehicles, it would not affect traditional recreational experiences in the primitive and semi-primitive motorized areas as much. Snow machines still would use traditional routes to access these areas, however. There would be few impacts on recreational cabin owners on the lower Goodpaster River because the Goodpaster River Bridge would not be accessible to floaters and fishers as would occur for Alternatives 2 and 3. Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, recreational impacts from public use would begin to approach those described for Alternative 2
4.17 Safety		
Shaw Creek Road egress. This option would cause some safety risk for the six year-round residences along the road. Overall, mine-related vehicle use would average between 10	No safety impacts were identified for this option. Safety issues similar to Shaw Creek Road (due to	Winter-only access. Would require moving large volumes of supplies during a relatively short window under very cold and dark conditions that would be more

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-Only Access)
and 20 round trips per day. During intense periods of mine construction, traffic would average ~50 vehicles per day. If the Applicant's shift-change bus station were located near the TAPS crossing, there would be two, approximately one-hour periods every 4 days, during each of which up to 180 vehicles would traverse the road. If the bus station were located on the Richardson Highway, the number of vehicles during each of these periods would be reduced to approximately six buses. The former location option would have a higher safety risk along Shaw Creek Road than would the latter location. Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State of Alaska has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. Because the road could be upgraded in the future if necessary, speed limits could be adjusted if appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low. DOT/PF may have to conduct a traffic impacts analysis, in conjunction with issuance of a drive way permit, which may result in specific mitigation measures being required. Tenderfoot egress. This option would have low safety impacts. Its use would eliminate the Shaw Creek Road safety issue. Road use. Opening the road to other users would cause a small increase in the safety risk to residents identified above. The increased risk would be due to more traffic (public and logging operations), and because typical users likely would not be as observant of speed limits as would drivers under specific direction from the Applicant. The safety risk, while increased, would still be low. Road disposition. If road were to remain open to other users after mine closure, this safety risk would continue. Security gate location. A security gate near the end of Shaw Creek Road would restrict public use and impacts would be low. A gate at Gilles Creek likely would result in considerably	recreational traffic, there is actually more non-mine traffic on the Quartz Lake road. The State made these comments on Chapter 5 as well and they should be included in both places)	likely to cause accidents. While the safety risk would be low, it would be tangible and higher than that associated with an all-season road. Road use. If winter-only access were open to everyone, there would be a moderate safety risk. Maintaining traffic control under these conditions just for Pogo project trucks would be a challenge. If other users were to be on the winter road/trail at the same time, the chances of an accident, particularly with a snow machine, would be substantially higher.

Table A-3 Summary of Direct and Indirect Effects of Surface Access Related Options Specific to Alternatives

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-Only Access)
more traffic than a gate near the end of Shaw Creek Road. Safety impacts, however, still would be low.		
4.18 Technical and Economic Feasibility		
Tenderfoot egress. While constructible, the route would cross difficult terrain, with poor soils and likely permafrost. Deep incised gullies indicate loess deposits that would require deep side hill cuts. Ascent and decent segments would require 5 to 7 percent grades for approximately 1.5 miles on each side of the ridge. Switchbacks would be required, with several curves having a radius less than the design criterion for 500 feet, and possibly less than the minimum of 300 feet. This option would require construction of an essentially new, ~3.5-mile road to the vicinity of end of existing Shaw Creek Road. A reasonable construction cost estimate is ~$2.5 million to $3.0 million to avoid using the existing Shaw Creek Road.	South Ridge all-season road. Soil and topography conditions along the first several miles of this route are difficult. They are characterized by steep slopes, many small drainages, and probable ice-rich soils, compared with good terrain and soil conditions on the Shaw Creek Hillside route. The steep slopes and angular talus in the vicinity of Shaw Creek Dome along the South Ridge route likely would make construction difficult. The elevated and exposed terrain, and severe winds experienced in the Delta region, would make maintenance more difficult and driving more hazardous, especially in blowing snow conditions. This route would be expected to be available for use approximately 10 fewer days than would the Shaw Creek Hillside route.	Technical feasibility. The focus of this issue is whether annual winter-only access would be feasible for mine life. Applicant estimates adequate winter supply window would be absent once in 13 years. Recent data confirming long-term climate warming in central Alaska may mean Applicant's estimate is optimistic. Economic feasibility. Constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-foot airstrip for remainder of year, raises many economic feasibility issues. ▪ Short window for mobilization of construction equipment and supplies for construction of all-season road segment ▪ Annual resupply of year's worth of fuel and supplies must occur during 8- to 10-week window. Rest of year project dependent solely on logistical air support ▪ Capital costs estimated at 53 percent higher. ▪ Annualized operating costs at 118 percent higher Winter-only access would add substantial capital and operating costs and increase the project's economic burden, and introduce an unreasonable level of complexity and business risk. This increased economic burden and unreasonable business risk were considered to have a major impact on the project's economic feasibility.

Table A-4 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.1 Surface Water Hydrology	
Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on hydrologic flow regimes of surface water.	Development of timber resources, mining, and public recreational and other uses all would have potential impacts on the surface water hydrologic regime that could be cumulative with the activities of the Pogo Mine project. Extension of the life of the Pogo project, development of hypothetical Sonora Creek and Slate Creek mines, or other resource developments occurring because of continued existence of an all-season road, individually would cause surface hydrologic impacts of a nature and magnitude similar to those from the proposed Pogo Mine project. Given their likely physical separation in different watersheds, the State of Alaska's management and regulatory tools, and the individual small impacts to the surface water hydrologic system, these mines and other resource developments would have low cumulative impacts on hydrologic flow regimes of surface water.
4.2 Groundwater Hydrology	
Absence of an all-season road would limit other resource development activities and human use and would result in very low cumulative impacts on ground water.	Cumulative impacts on groundwater resources in the area could result from development associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. Assuming sound management practices and permitting stipulations, and because such development activities would be distributed over such a large area, there would be low cumulative impacts on ground water.
4.3 Water Quality	
Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on water quality.	Cumulative impacts on water quality could result from increased traffic associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. During road extension construction, disturbed surfaces could erode and increase sediment in runoff that could cause increased suspended sediment in waterways. Such increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of BMPs during construction and revegetation. These impacts cumulatively would be small. Additional transport of fuel, chemicals, and ore would increase risk of an accident and subsequent release that could affect water quality. The degree of increased risk would be proportional to the increase in commodity transport. If discharges from the hypothetical mines were similar to those projected from the Pogo Mine, slight increases in concentrations of a few parameters could occur, but the differences would be difficult to detect under most flow conditions. Overall, water quality cumulative impacts from maintaining the road would be low.
4.4 Air Quality	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts on air quality other than those of fugitive dust associated with road reclamation.	Although there would be minute impacts in the general area of any other developed project as a result of long-range transport of air pollutants, the distances between projects likely would be such that air quality emissions of any one project would not affect the ability of any other projects to be permitted. The permitting processes are used to ensure that cumulative impacts of new as well as existing projects do not result in exceeding the National Ambient Air Quality Standards and Alaska Ambient Air Quality Standards. The construction and use of new access roads to the hypothetical Sonora Creek and Slate Creek mines would generate additional fugitive dust during construction and operation of the roads themselves as well as other facilities associated with these hypothetical projects. Fugitive dust also would be generated by an airstrip associated with a new Slate Creek mine. Such fugitive dust impacts would be small and limited to the local

Table A-4 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
	area. Overall, air quality cumulative impacts from maintaining the all-season road would be very low.
4.5 Noise	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative noise impacts other than those associated with road reclamation.	The primary area for cumulative noise impacts concern would be at the residences located along the existing Shaw Creek Road. With continued all-season road operation, it would be possible that traffic could increase substantially over time from logging, other industrial/commercial developments, and a road be open to the public. For a least one residence on Shaw Creek Road, this cumulative increase could approach a high impact In other areas, noise from road use and scattered developments is not projected to result in any high local long-term noise impacts. There may be times in certain areas, however, when cumulative noise from different sources could result in a substantial, temporary short-term noise level increase.
4.6 Wetlands	
Absence of an all-season road would limit other resource development activities and human access. Cumulative wetland impacts to the time the road was removed would include those from the Pogo project itself, the road to the mine, and off-road ATV use from the road. These impacts would be moderate with the Shaw Creek Hillside all-season road and low with the South Ridge all-season road, in the context of the Shaw and Goodpaster drainages.	Mine developments such as a hypothetical Sonora Creek mine would increase wetland impacts, but the location of the hypothetical mine close to the Pogo project's infrastructure would limit those impacts to an assumed 75 acres. A hypothetical Slate Creek mine accessed by extension of the Pogo all-season road would directly eliminate an assumed additional 200 acres of wetlands, including some of high value in the Goodpaster River Valley. Impacts would be limited through permitting processes. The maintained road would accelerate timber harvests. Although these harvests would focus on uplands, roads would require some wetland crossings, including impacts to valuable slope and riverine wetlands. Effects would be greater with a Shaw Creek Hillside all-season road than with a South Ridge all-season road because more timber harvests likely would occur in the Shaw Creek drainage, which contains more wetlands. An all-season road open to everyone would cause a moderate cumulative impact to wetlands in the Shaw Creek and Goodpaster River drainages. A few hundred acres of wetlands would be eliminated; a few hundred more would be slightly degraded by proximity to commercial and industrial structures and activity; and more would be severely degraded by recreational and subsistence activities, particularly those employing ATVs. While the impacts would affect a small proportion of the wetlands in the Shaw and Goodpaster drainages, the effects would be detectible on the scale of those drainages. Wetland impacts related to residential and commercial land development near the Richardson Highway would continue to be stimulated by ongoing resource extraction and public use activities associated with the road.
4.7 Surface Disturbance	
Not applicable.	Not applicable.
4.8 Fish and Aquatic Habitat	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts to fish and aquatic habitat.	Direct and indirect cumulative impacts would occur from extraction of timber and mineral resources, and increased recreational use from access opportunities and population growth. Although impacts could be minimal in any one occurrence, over time these impacts cumulatively would result in habitat loss and smaller, though still viable, fish populations. The brunt of this cumulative impact would fall on recreational users of the Goodpaster River through more restrictive regulations on fish harvest and possibly access. Additional mineral development would increase risks due to land disturbance and upsets from accidents and natural events. A hypothetical Slate Creek mine would involve an additional 25 miles of road on the

Table A-4 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
	Goodpaster River Valley floor adjacent to the river. Proper design, construction, and permitting stipulations, as well as State of Alaska management practices, could mitigate such risks. Overall, cumulative impacts would be moderate, and high only locally.
4.9 Wildlife	
Absence of an all-season road would reduce considerably resource development and related direct and indirect cumulative impacts on wildlife, particularly caribou.	Cumulative direct impacts to habitat, birds, and mammals under the TBAP from scattered timber and mining resource developments could be high on a scattered local basis, but would be low in the context of the Shaw Creek and Goodpaster River valleys. If these developments were connected by an all-season road it likely would increase resource development further, which could have a moderate cumulative indirect habitat effect on some wildlife species. A likely effect of increasing mineral exploration and development activity would be harassment of wildlife by aircraft, both intentional as well as unintentional, particularly by low-flying helicopters. In combination with general, nonmineral-related aviation, and the U.S. Air Force's aerial combat training, these activities could substantially increase cumulative impacts on caribou. Of particular concern would be disturbance to the Fortymile Caribou Herd during its critical calving period. Extension of an all-season road to a hypothetical Slate Creek mine would expand year-round human activities and push the perimeter of habitat fragmentation to the edge of the herd's summer range. It is not possible to predict the degree of cumulative indirect habitat loss because road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative indirect impacts would be very likely.
4.10 Threatened and Endangered Species	
There would be no cumulative impacts on threatened or endangered species. Absence of an all-season road would substantially reduce cumulative impacts on sensitive species.	There would be no cumulative impacts on threatened or endangered species. Cumulative impacts on sensitive species would occur, especially if the road were extended to a hypothetical Slate Creek mine. The degree of cumulative impacts is not possible to predict because future developments are speculative.
4.11 Socioeconomics	
Absence of an all-season road would lower the probability for other resource developments in the project area, and could slow long-term economic growth based on such development.	By end of decade, with construction of the NMDS and/or a natural gas pipeline and the Pogo Mine, a cumulative total of between ~430 and 605 new permanent jobs could be added to the local economy for substantial positive economic effect. Most of the increase would be due to NMDS. Total Delta area population would rise to ~2,300 to 2,400. Pogo would directly or indirectly account for between 11 and 15 percent of population, a substantial effect. Estimated personal Delta area income would increase from ~$45 million in 2000 to ~$52 million to $54 million. The cumulative effect on local schools could be substantial, and demand for other public services also would increase, though not necessarily at a rate proportional to population increase. Although housing availability could be tight during NMDS construction, longer term cumulative effects on local housing market generally would be positive, resulting in increased valuations and additional housing

Table A-4 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
	construction. At the same time, local rental rates could rise.
4.12 Land Use	
Absence of an all-season road would limit other resource development activities and human use, and would change then existing land uses by removing the access that had allowed for mining development.	Cumulative impacts would be low because all uses likely would be compatible with adopted land use plans. *Changes* to existing land uses, however, could be substantial. A road to a hypothetical Slate Creek mine likely would cause changes to existing land use even though such change would be compatible with adopted land use plans. Remote reaches of the upper Goodpaster River would become more economically accessible to new commercial/industrial land uses, possibly opening up other adjacent mining areas in the future. Existing trappers, recreationists, and other users of the area likely would consider such infrastructure a substantial change to existing land uses, while new commercial and industrial land users would consider such infrastructure a substantial benefit.
4.13 Subsistence	
Absence of an all-season road would considerably reduce resource development and recreational access to subsistence use areas that are currently difficult to access, and thus would have substantially fewer cumulative impacts.	Direct subsistence impacts of a hypothetical Sonora Creek mine would be similar to those for the Pogo Mine because of its closeness to the Pogo Mine infrastructure. A Slate Creek mine near the headwaters of the Goodpaster River accessed by an all-season road would provide even greater access into a currently inaccessible area, especially if open to use by everyone. Such a road would extend well inside the edge of the Fortymile Caribou Herd's recent annual range. Road extension into the herd's range is a particular concern of subsistence users. With the exception of caribou and moose, however, the area between the Pogo Mine site and a hypothetical Slate Creek mine site is outside recent subsistence use areas. Although a road to such a mine would not in itself have a high impact on current subsistence uses because it is outside of current subsistence use areas, subsistence users likely would perceive it as a further cumulative encroachment of the "wilderness" to the north and another step toward connecting to the Taylor Highway and "surrounding" the village of Healy Lake with roads and modernization. Construction of a new road represents a classic fear of cumulative impacts from a road, because, in the view of the subsistence workshop attendees, "roads beget more roads." The land use policies that would permit a road to the Pogo Mine site could do likewise for other resource developments, and through Alaska Industrial Development and Export Authority or another vehicle might even help fund more roads. Thus, maintaining an all-season road could have a major cumulative impact on subsistence resources. These impacts, however, could be mitigated if the State of Alaska undertook appropriate land and resource management policies for the area that would limit public access to, and impacts on, subsistence resources.
4.14 Cultural Resources	
Absence of an all-season road would decrease human presence considerably, and surface artifacts and other cultural resources would be less vulnerable to looting and other types of damage.	No major cumulative impacts would be expected from major developments because adherence to cultural-resource protection procedures under CFR 800, Section 106, would be required. Because additional road users would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage if the road were maintained after Pogo Mine closure, cumulative impacts could be increased. If a road to a hypothetical Slate Creek mine were open to public use, the potential for impacts to cultural resources would further increase.

Table A-4 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.15 Visual	
Removal and reclamation of the all-season road would result in a slow restoration process as vegetation reclaimed the corridor over time, and there would be no or low cumulative visual impacts.	Hypothetical mines developed because the all-season road was maintained would cumulatively contribute to visual impacts because of natural vegetation clearing for surface and air access, power, and other mine-related facilities. A road extension from Pogo to a hypothetical Sonora Creek mine would be minimally visible from the Goodpaster River, and would have low visual impacts for river users. Because of its relatively short length and location close to the substantial Pogo infrastructure, the road extension also would have low visual impact to airborne viewers. Visual impacts from mine site facilities themselves would be major only to ground viewers within the context of the Sonora Creek drainage, but would be low in a larger context to airborne viewers because of proximity of the facilities to the substantial Pogo infrastructure. A road extension up the Goodpaster Valley to a hypothetical Slate Creek mine could have a high visual impact to floaters on the river, as well as airborne viewers, in the context of the upper Goodpaster Valley. Visual impacts from mine site facilities themselves would be high to ground viewers within the context of the Slate Creek drainage. In conjunction with a road up the Goodpaster Valley, these facilities would have a high visual impact to airborne viewers within the context of the upper Goodpaster Valley.
4.16 Recreation	
Although removal and reclamation of the all-season road would result in a definite impact on new recreational users, there would be no cumulative impacts because there were no other current or foreseeable future actions identified that also would reduce access for recreation in the project area.	Pogo mining activities, as well at the potential for extending the life of the Pogo project and the hypothetical Sonora Creek and Slate Creek mines, would substantially affect ROS classes in these areas. Primitive and semi-primitive motorized ROS classes would change to semi-primitive motorized and roaded natural. If the road were maintained and open to public use, and if additional mines or other developments occurred farther up the Goodpaster Valley, recreational access would increase to these locations. Thus, road maintenance and public use could have a high cumulative recreational impact on existing recreational users as well as a high beneficial cumulative recreational benefit to prospective recreational users.
4.17 Safety	
Removal and reclamation of the all-season road would have no cumulative impacts on safety because there were no other current or foreseeable future actions identified that also would reduce safety issues in the Shaw Creek Road area.	If the Shaw Creek Road egress option were used and the road were open for use by everyone, there could be a cumulative safety impact on residences along Shaw Creek Road from public use and timber harvest-related traffic in addition to use by the Pogo project. If this status were maintained after mine closure, cumulative safety impacts likely would increase if other major developments were to occur and public use were to intensify. These impacts could be mitigated by the Alaska Department of Transportation and Public Facilities' traffic management measures on both existing Shaw Creek Road and the all-season road
4.18 Technical and Economic Feasibility	
Not applicable.	Not applicable.

Abbreviations and Acronyms

Acronyms and Technical Abbreviations

AAC	Alaska Administrative Code
AAAQS	Alaska ambient air quality standards
AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council on Historic Preservation
ADFG	Alaska Department of Fish & Game
ADEC	Alaska Department of Environmental Conservation
ADCED	Alaska Department of Community and Economic Development
ADNR	Alaska Department of Natural Resources
ADOL	Alaska Department of Labor and Workforce Development
ADOT/PF	Alaska Department of Transportation and Public Facilities
AFN	Alaska Federation of Natives
AHRS	Alaska Heritage Resources Survey
AIDEA	Alaska Industrial Development and Export Authority
AMSL	Above mean sea level
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
APE	Area of potential effect
AS	Alaska Statute
ASTM	American Society for Testing and Materials
ATCO	Alberta Trailer Company
ATM	Alaska test method
ATV	All terrain vehicle
BAT	Best available technology
BATF	Bureau of Alcohol, Tobacco, and Firearms
BCT	Best conventional technology
BMP	Best management practice
BOD	Biochemical oxygen demand
BOM	U.S. Bureau of Mines
$CaCO_3$	Calcium carbonate
CCC	Criterion chronic concentration

CEQ	Council on Environmental Quality
CFR	U.S. Code of Federal Regulations
CIL	Carbon-in-leach
CIP	Carbon-in-pulp
CITES	Convention on International Trade in Endangered Species
CMC	Criterion maximum concentration
CN	Cyanide
CO	Carbon monoxide
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act
DEIS	Draft environmental impact statement
DGSD	Delta Greely School District
DMTC	Delta Mine Training Center
DOF	Alaska Division of Forestry
EFH	Essential fish habitat
EIS	Environmental impact statement
EO	Executive order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EUD	Ecological unit description
FAA	Federal Aviation Administration
FC	Fecal coliform
FCC	Federal Communications Commission
FCHPT	Fortymile Caribou Herd Planning Team
FHWA	U.S. Federal Highway Administration
FNSB	Fairbanks North Star Borough
FR	Federal Register
FY	Fiscal Year
GIS	Geographical information system
GMU	Game Management Unit
GVEA	Golden Valley Electric Association
HDS	High density sludge
HGM	Hydrogeomorphic
LOEC	Lowest observed effect concentration
MCL	Maximum contaminant level

MOU	Memorandum of Understanding
MSHA	Mining Safety and Health Administration
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMDS	National Missile Defense System
NMFS	National Marine Fisheries Service
NOEC	No observed effect concentration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	U.S. National Park Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
O_3	Ozone
OSHA	Occupational Safety and Health Administration
PA	Programmatic agreement
Pb	Lead
PDEIS	Preliminary draft environmental impact statement
PLC	Programmable logic controller
PSD	Prevention of Significant Deterioration (state air quality permit)
RCRA	Resource Conservation and Recovery Act
ROD	Record of decision
ROS	Recreation Opportunity Spectrum
ROW	Right of way
RTP	Recycle tailings pond
SAS	Soil absorption system
SDWA	Safe Water Drinking Act
SHPO	State Historic Preservation Office
SO_2	Sulfur dioxide
SOFI	Statement of Financial Interest
SPCC	Spill prevention, control, and countermeasure
SDWA	Safe Drinking Water Act
TAPS	Trans-Alaska Pipeline System
TBAP	Tanana Basin Area Plan
TCC	Tanana Chiefs Conference

TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TSS	Total suspended solids
TVSF	Tanana Valley State Forest
UAF	University of Alaska at Fairbanks
UIC	Underground injection control
USAF	U.S. Air Force
USC	United States Code
USCG	U.S. Coast Guard
USDI	U.S. Department of Interior
USDOT	U. S. Department of Transportation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAC	Visual absorption capability
WAD	Weak acid dissociable
WAMCATS	Washington and Alaska Military Communications and Telegraph System

Measurement Abbreviations

cfm	Cubic feet per minute
cfs	Cubic feet per second
cu yd	Cubic yard
dB	Decibel
dBA	Decibel A-weighted
dBC	Decibel C-weighted
ft	Feet
gpd	Gallons per day
gpm	Gallons per minute
kV	Kilovolt
kW	Kilowatt
L_{eq}	Equivalent sound pressure level
L_{max}	Greatest root-mean square sound level
L_{min}	Smallest root-mean square sound level
L_n	Sound level exceeded "n" percent of the time
m	Meter
mbf	Million board feet
mg/L	Milligrams per liter
m^2/s	Square meter per second
MRL	Method reporting limit
NTU	Nephelometric turbidity unit
oz	Ounce
ppm	Parts per million
sq mi	Square mile
tpd	Tons per day
UCU	Uniform coding unit
µg/L	Micrograms per liter
$\mu g/m^3$	Micrograms per cubic meter
Yd^3	Cubic yard

Chapter 1 Introduction

1.1 Summary of Proposed Action

The proposed action is a plan by Teck-Pogo Inc., the Applicant, to develop the underground Pogo Mine on State of Alaska land in the Goodpaster River Valley approximately 38 miles northeast of Delta Junction, Alaska. The mine would process approximately 2,500 tons of ore per day (tpd), and would produce approximately 375,000 ounces (oz) of gold annually at start-up, with a possibility of increasing production and expanding the mill to approximately 3,500 tpd and 500,000 oz annually.

The Applicant would like to begin project construction as soon as possible in 2003. The project would require 25 to 33 months to construct and would have an operating life of approximately 11 years, based on current ore reserves. Its life could be extended if additional reserves were found. The capital cost of the project is estimated at $200 million to $250 million. The mine would operate 365 days a year with an initial workforce of approximately 288.

As proposed, the proposed action would include a 49.5-mile access road, a mill and camp complex, a dry-stack tailings pile and recycle water tailings pond, an airstrip, gravel pits, laydown and fuel storage areas, and a local network of roads. Gold would be recovered by gravity separation, flotation concentration, and cyanide vat leaching. Approximately half of the tailings would be returned underground as a paste backfill. Power would be supplied from the regional grid via a 50-mile power line.

1.2 Purpose and Need for Action

Need for Action

The need for the proposed action is to allow the Applicant to develop an underground mine in its nonfederally owned Pogo claim block in order to produce gold and to make a reasonable profit.

Purpose for Action

The purpose of the proposed action is to provide the federal authorizations needed by the Applicant to construct and operate an underground gold mine and associated facilities in and near its Pogo claim block, which is located in a currently roadless area 38 miles northeast of Delta Junction, Alaska, near the Goodpaster River. The mine would process between 2,500 and 3,500 tpd of ore for at least 11 years to supply an on-site mill, which would produce up to approximately 500,000 oz of gold per year through gravity recovery, froth flotation, and cyanide leaching of concentrate. The proposed action would meet the objectives for construction and operation of the mine by providing:

- An efficient, on-site mill and gold extraction process
- Safe, stable, long-term disposition of 11 million tons of tailings with sufficient capacity to contain potential additional ore reserves
- An adequate water supply to meet mill process and camp complex requirements
- A safe water discharge system

- 10 to 14 megawatts (MW) of electrical energy needed to construct and operate the mine and mill
- A comfortable on-site camp complex capable of supporting 250 to 700 personnel needed to construct and operate the mine and mill
- Reliable and safe access to the mine for (1) delivery of materials, including approximately 2 to 3 million gallons of fuel and 27,000 to 42,000 tons of non-fuel supplies per year and (2) the 250 to 700 personnel needed to construct and operate the mine and mill on a cost-efficient basis
- Timely project development
- Development of the project in a technically and economically feasible manner

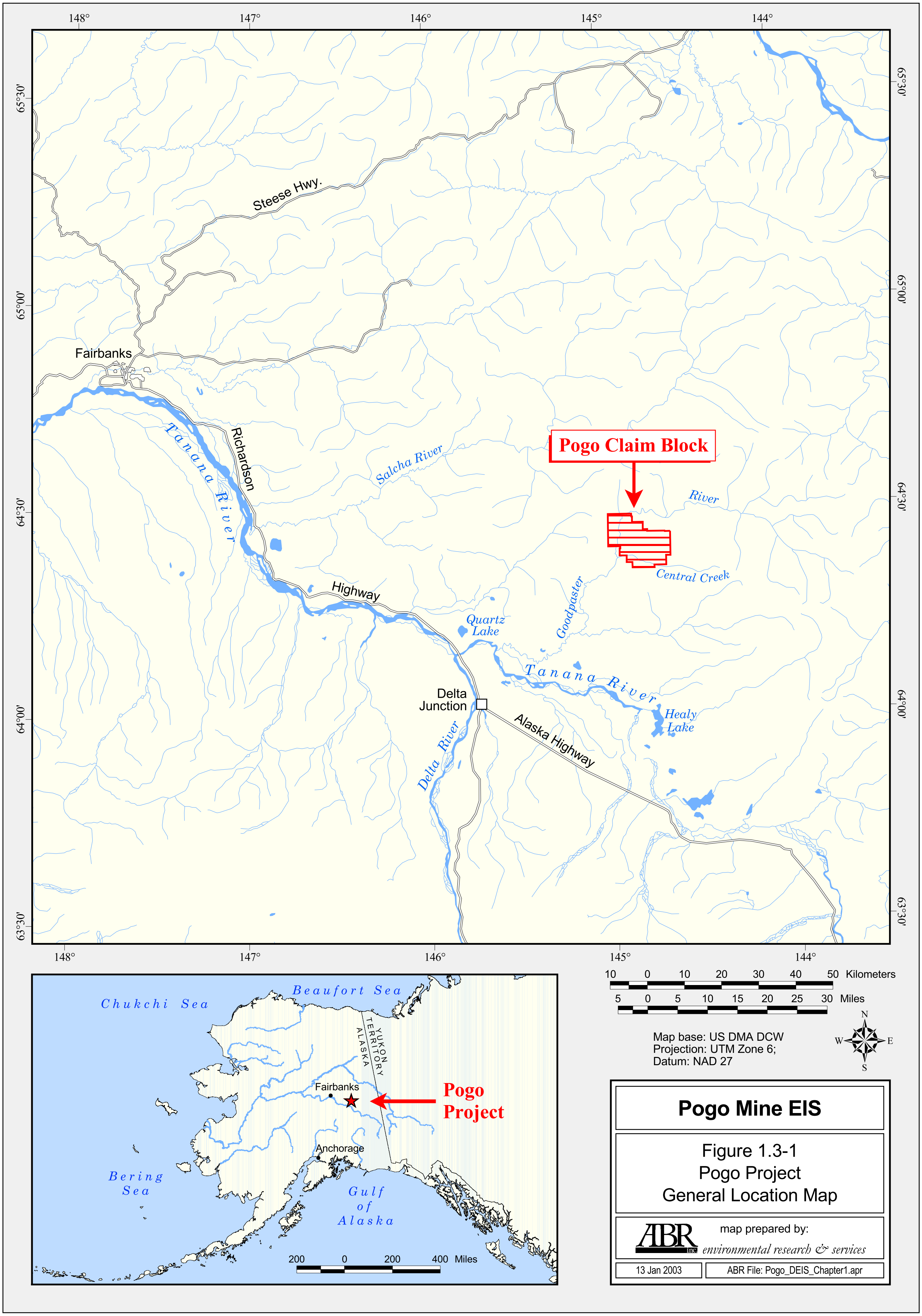
1.3 Proposed Project Location, Land Status, and History

The proposed Pogo Gold Mine ore body is located approximately 38 miles northeast of Delta Junction, Alaska, immediately adjacent to the Goodpaster River (Figure 1.3-1). Virtually all of the project's components, including surface access, would be located within a large block of roadless, multiple-use State of Alaska land (Figures 1.3-2 and 1.3-3). Exploration has proceeded to date with access only by air and winter ice road.

The Pogo deposit is a recent discovery, found through "grassroots" exploration of an area with promising geology but very little prior mining history. In 1981, while conducting a regional mineral potential evaluation, WGM, Inc., discovered gold, arsenic, and tungsten anomalies in stream samples taken from Pogo and Liese creeks. Claims were staked over these areas in 1991 as part of the Stone Boy Joint Venture. Exploration work was carried out by WGM and financed by Sumitomo Metal Mining, Inc. (Sumitomo), and several other companies, which eventually withdrew from the venture. The Applicant signed a letter of intent in June 1997 to acquire a 40 percent interest in the Pogo claims from Sumitomo, and assumed operatorship in the spring of 1998.

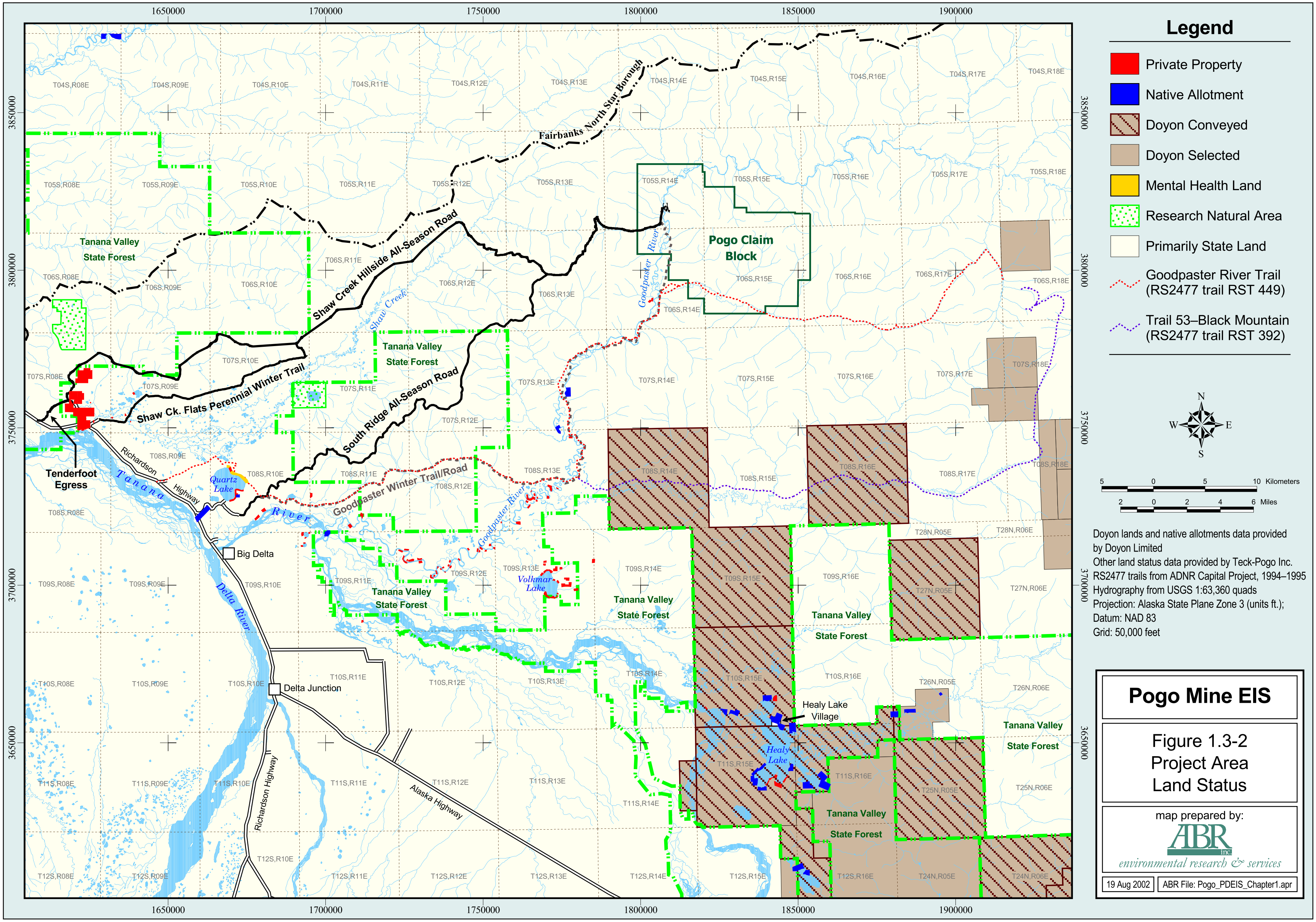
Exploration work on the Pogo claims from 1991 to 1999 consisted of grid-based soil sampling, prospecting, and geophysics. Three diamond drill holes were undertaken in 1994, targeting a large gold-in-soil anomaly (irregularity) and a magnetic anomaly in Liese Creek. Encouraging results led to 13 additional drill holes in the Liese Creek area in 1995, and the discovery of the "Liese Zone" – one or more low-sulfide quartz veins with gold.

In late 1997, the Applicant and Sumitomo purchased the Faith Claims on Pogo Creek from Jack Stewart, a placer miner who had sporadically worked the state claims since staking them in the mid-1980s. In the winter and early spring of 1998, the Applicant constructed a 49-mile winter ice road and hauled in underground exploration equipment and supplies. A 48-person Alberta Trailer Company (ATCO) trailer camp with laydown and fuel storage areas was constructed on a portion of Jack Stewart's previous disturbance. In March 1999, underground exploration began with the driving of a 5,000-foot adit toward the ore deposit. The ore zone was reached a year later, in April 2000. Additional geological, geotechnical, and mining engineering data were gathered from the underground activity during 2000 and 2001.

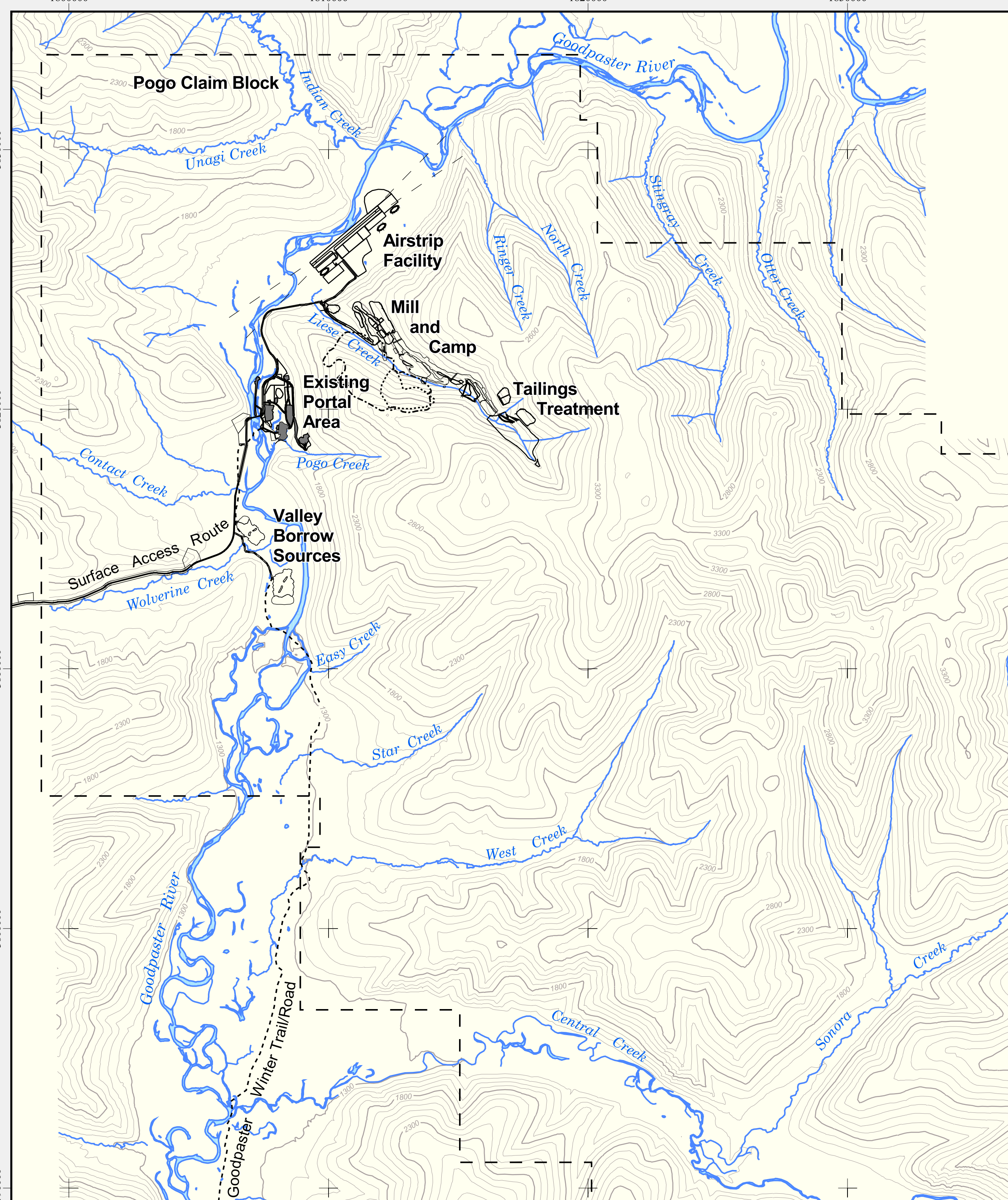


Pogo Mine EIS

Figure 1.3-1
Pogo Project
General Location Map



Legend
Private Property
Native Allotment
Doyon Conveyed
Doyon Selected
Mental Health Land
Research Natural Area
Primarily State Land
Goodpaster River Trail (RS2477 trail RST 449)
Trail 53–Black Mountain (RS2477 trail RST 392)
N
S
E
W
5 0 5 10 Kilometers
2 0 2 4 6 Miles
Doyon lands and native allotments data provided by Doyon Limited
Other land status data provided by Teck-Pogo Inc.
RS2477 trails from ADNR Capital Project, 1994–1995
Hydrography from USGS 1:63,360 quads
Projection: Alaska State Plane Zone 3 (units ft.);
Datum: NAD 83
Grid: 50,000 feet
Pogo Mine EIS
Figure 1.3-2
Project Area
Land Status
map prepared by:
ABR inc.
environmental research & services
19 Aug 2002
ABR File: Pogo_PDEIS_Chapter1.apr
Pogo Claim Block
Fairbanks North Star Borough
Shaw Creek Hillside All-Season Road
Shaw Ck. Flats Perennial Winter Trail
South Ridge All-Season Road
Goodpaster Winter Trail/Road
Tanana Valley State Forest
Tenderfoot Egress
Richardson Highway
Tanana River
Quartz Lake
Big Delta
Delta River
Delta Junction
Goodpaster River
Shaw Creek
Volkmar Lake
Healy Lake Village
Healy Lake
Alaska Highway
1650000
1700000
1750000
1800000
1850000
1900000
3850000
3800000
3750000
3700000
3650000



Contours and hydrography by AeroMap U.S., Inc., 1997
Contour interval: 100 feet
Mine site facilities from AMEC
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 10,000 feet

0.5 0 0.5 1 1.5 Kilometers

0.5 0 0.5 1 Miles

Pogo Mine EIS

Figure 1.3-3
Pogo Mine Site Area

map prepared by:
ABR inc
environmental research & services

28 Jan 2003 | ABR File: Pogo_DEIS_Chapter1.apr

1.4 EIS Development Process

The Applicant has applied to the U.S. Environmental Protection Agency (EPA) for a National Pollutant Discharge Elimination System (NPDES) permit to discharge waste waters from the Pogo mine project from an off-river treatment works to a channel connected to the Goodpaster River. This project is considered a “new source” discharge and, in accordance with Section 511(c)(1) of the Clean Water Act (CWA), is subject to the provisions of the National Environmental Policy Act (NEPA). Because the proposed project has the potential to significantly affect the quality of the human environment, the decision on issuance of the NPDES permit is considered a “major federal action.” NEPA requires preparation of an environmental impact statement (EIS) for all major federal actions.

The NEPA compliance program requires analysis of information on potential impacts, including environmental, cultural, social, economic, and public health impacts; development and analysis of options to avoid and minimize impacts; and development and analysis of measures to mitigate adverse impacts. EPA's NEPA compliance responsibilities include several statutes and executive orders that must be addressed during the NEPA process. Examples include the Endangered Species Act, the Executive Order on Environmental Justice, and executive orders on wetlands, floodplains, farmland, biodiversity, and tribal government coordination and consultation. The Council of Environmental Quality (CEQ) regulations for implementing NEPA may be found in the U.S. Code of Federal Regulations (CFR), Title 40, Parts 1500-1508. The EPA’s regulations on compliance with NEPA are located in 40 CFR 6. After completing the final EIS, EPA will prepare a record of decision (ROD) that sets forth EPA's basis for issuing or denying the NPDES permit.

In the fall of 1997, the Applicant began discussions with various state and federal agencies about underground exploration permits, and later initiated pre-development discussions. In June 2000, Teck-Pogo Inc., as prospective Applicant for the project’s NPDES permit, entered into a Memorandum of Understanding (MOU) with EPA that established the conditions and procedures to be followed in preparation of the EIS. On August 1, 2000, the Applicant filed an application for an NPDES permit to discharge waste waters to a soil absorption system and to underground injection wells on the Goodpaster River Valley floor. This application formally commenced the EIS process. On January 2, 2003, the Applicant filed an amended NPDES application to discharge waste waters from an off-river treatment works on the Goodpaster River Valley floor to a channel connected to the Goodpaster River.

EPA has assumed lead federal agency responsibility for preparation of the EIS and, in accordance with its implementation of NEPA regulations, has determined that it will prepare the EIS with the use of a third-party contractor. The EPA and Applicant MOU provided for engaging a third-party contractor to develop the EIS under the direction of EPA. A third-party contractor supplies technical expertise and other assistance directly to a federal agency. The contractor works under that agency's direct supervision and not for the Applicant. The costs for the contractor's services are reimbursed by the Applicant under the terms of the MOU. Michael Baker, Jr., Inc., a large international engineering and environmental firm with a strong presence in Alaska, was selected as the third-party contractor in June of 2000, and immediately commenced work. The contractor has no financial interest in the outcome of the project and has filed a formal Statement of Financial Interest (SOFI) to that effect.

Additional information about the Pogo Mine EIS process, including baseline reports and technical documents, can be found on the Web at http://www.pogomineeis.com.

Cooperating Agencies

In order to construct and operate the mine, many federal and state permits are needed. Therefore, the EIS has been prepared with EPA as the lead agency and the U.S. Army Corps of Engineers (COE) and State of Alaska Department of Natural Resources (ADNR) as cooperating agencies. This EIS may be used by agencies as a basis for a permit decision-making process and their own ROD or other appropriate procedure. The authorities under which this action is being proposed are listed in Section 1.7 (Agency Roles and Responsibilities).

1.5 Scoping

As required by the CEQ regulations (40 CFR 1501.7) and EPA regulations (40 CFR 6.400), EPA provided for an early and open process to determine the scope of issues to be addressed and to identify the significant issues related to the Pogo Mine project. EPA accomplished these objectives through early public, tribal, and agency involvement in regular meetings, and by conducting a thorough public and agency scoping process.

On August 11, 2000, EPA published a Notice of Intent (NOI) to prepare an EIS for the Pogo Mine Project in the *Federal Register* (FR). On the same date, EPA distributed the *Scoping Document for the Pogo Mine Project Environmental Impact Statement* (EPA, 2000) that described the proposed project, the EIS process, and a document preparation schedule. Distribution of the scoping document began a 60-day public and agency review and comment period that ended on October 10, 2000. EPA hosted two scoping open houses during that period. The first was held on September 26, 2000, in Delta Junction at the Delta Junction Community Center, and the second was held on September 27, 2000, in Fairbanks at the Noel Wien Library. Attendance totals were 46 and 50, respectively.

The scoping open houses served two purposes. One was to listen to and record the public's comments about the proposed project as described in the scoping document. The second was to respond to the public's requests for the background information and hands-on technical assistance that might be needed to fully understand the project description and proposed scope of the EIS analysis before commenting. EPA project staff, other agency representatives, and members of the third-party contractor, Michael Baker, Jr., were available to answer questions and explain methodologies.

A "town meeting" format provided an opportunity for individuals to comment and promoted group interaction. All comments made during the open houses, whether oral or written on comment sheets or flip charts, were documented as part of the official record. While people were welcome to make comments and suggestions during the open houses, the record was specifically left open for an additional 13 days to accommodate anyone needing additional time to formulate comments.

Sixty-two sets of comments were received, excluding those received during government-to-government consultations. In five of these cases, individuals gave very similar comments on two or more occasions, usually orally and in writing. Thus, 57 individual sets of non-tribal comments were received. Because some written comments were signed by more than one individual or organization, 64 entities actually commented. EPA will accept public comments throughout preparation of this EIS.

On January 30, 2001, EPA distributed a 55-page *Pogo Mine EIS Scoping Responsiveness Summary* (EPA, 2001a). This document described the scoping process, and:

- Included 17 pages of representative public and agency comments as well as 4 pages of tribal comments
- Described how the comments were evaluated
- Listed the 17 issues identified by the scoping comments
- Identified the project's component options to address those issues
- Described how evaluation criteria were developed for the issues and how those criteria would be used to evaluate the component options and identify project alternatives to be analyzed in the EIS
- Discussed activities that would follow the scoping process and identified sources of information
- Presented an EIS/NPDES permitting process and time line diagram
- Presented a draft EIS table of contents

Government-to-Government Consultations

In addition to the EIS scoping effort, pursuant to Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments), EPA undertook a concerted government-to-government consultation effort with the 13 Tribes listed below. These Tribes were considered to be potentially affected by the proposed Pogo Gold Mine by virtue of their location (1) within a 125-mile radius of the proposed Pogo Mine site, or (2) within the potentially affected Tanana River watershed. A detailed description of this consultation process is contained in Section 7.13 of this EIS.

Circle Native Community
Dot Lake Village Council
Healy Lake Tribal Council
Manley Village Tribal Council
Mentasta Traditional Council
Native Village of Eagle
Native Village of Minto
Native Village of Tanana
Nenana Native Village
Northway Traditional Council
Tanacross Village Council
Tetlin Village Council
Tok Traditional Council

1.6 Issues and Concerns

The scoping comments identified 17 major issues related to construction, operation, and closure of the proposed project. These issues served as the basis for development of criteria that were used to evaluate the various project options and alternatives, as described in Chapter 2. The 17 issues identified from public, agency, and tribal scoping comments were:

- Surface and groundwater quality
- Wetlands
- Fish and aquatic habitat
- Wildlife
- Recreational resources and uses
- Existing privately-owned lands and existing recreational and commercial uses
- Subsistence and traditional uses

- Air quality
- Noise
- Safety
- Reclamation
- New industrial and commercial uses
- Cultural resources
- Socioeconomics
- Cumulative impacts
- Technical feasibility
- Economic feasibility

1.7 Draft EIS Public Comments and Responses

The draft EIS comment period formally began with a notice of availability published in the *Federal Register* on March 14 , 2003, and closed 60 days later on May 13, 2003, although comments received after the closing date have been considered and responded to. In addition, public meetings during which comments and testimony were taken were conducted in Delta Junction on April 29, 2003, and in Fairbanks on April 30, 2003.

The 184 commenters made a total of approximately 641 comments. These figures do not include comments received during government-to government consultations discussed above. All public and agency comments, and responses to them, are contained in Appendix E of this final EIS.

1.8 Agency Roles and Responsibilities

1.8.1 Responsible Official and Decision to Be Made

The Pogo Mine project requires a NPDES permit for project-related water discharges. The project is defined as a new source by the NPDES regulations (40 CFR 122.2 and 122.29). Under the CWA Section 511(c)(1), a new source is subject to compliance with NEPA prior to taking a final action on the NPDES permit (40 CFR Part 6, Subpart F). Thus, EPA is following a specific procedure that began with scoping and data collection and continues with analysis of data to identify and evaluate alternatives. The results of these analyses are documented in this EIS and form the basis for EPA's decision on the NPDES application. EPA's Region 10 Administrator is the responsible official for this decision.

The responsible official may decide to adopt:

- The No Action Alternative
- One of the action alternatives
- An alternative that combines features of more than one alternative
- One of the action alternatives with additional mitigation measures

EPA's ROD documenting the EIS conclusions will result in a decision on the Applicant's NPDES permit application. EPA will approve or deny the application, or require that the Applicant revise its proposed project prior to approval.

The Pogo Mine project requires a Clean Water Act Section 404 permit for discharge of dredged and/or fill material into waters of the U.S., including wetlands, prior to conducting the work (33 U.S.C. 1344). The impact on waters of the U.S. has been documented in this EIS and will be the basis for the COE decision on the Applicant's Section 404 permit application. The alternatives analysis contained in this EIS will be the basis for determining compliance with the EPA's Section 404 (b)(l) guidelines.

The State of Alaska will use this EIS to assist in its separate permit adjudication process, and will make its determinations on a schedule coordinated with the EIS process. If EPA were to decide against issuance of a NPDES permit, the state could still issue its authorizations if the project was redesigned so that an NPDES permit would not be required.

1.8.2 Agency Roles and Responsibilities (Permits and Approvals)

Preparation of this EIS and the permitting process are related but also distinct activities. The EIS is designed to explore project alternatives and discuss relative environmental impacts. Permitting gives government decision-makers a process to enforce certain conditions that are mandated by statute or regulation, and to require individual stipulations to eliminate or mitigate project-specific adverse environmental impacts identified in the EIS.

Many federal and state permits and approvals would be required for the Pogo Mine Project. Following is a list of the agencies involved in permitting, consultations, or otherwise providing authorizations for the project, with a description of their major permits, authorizations, or authorities. A succinct list of the major permits and authorizations required for project development is contained in Chapter 9.

Federal Government

Environmental Protection Agency (EPA)

- Section 402 NPDES Water Discharge Permit
- Section 404 Permit Review
- Spill Prevention, Control, and Countermeasure (SPCC) Plan
- Stormwater Construction and Operation Permit
- Underground Injection Control (UIC) Permit
- Section 106 Historical and Cultural Resources Protection
    - ✦ **Section 402 NPDES Water Discharge Permit.** Sections 301 and 306 of the CWA require that EPA develop wastewater effluent standards for specific industries, including gold mines. These standards are established both for existing sources and new sources. Because the project is a new source, New Source Performance Standards (NSPS) for gold mines and mills are applicable to the project (40 CFR 440.104). Section 402 of the CWA requires that the Pogo Mine project obtain an NPDES permit for its proposed discharge. The NPDES permit would be required to meet the NSPS or the water quality standards, whichever provides the more stringent limitation.

      In accordance with Section 511(c)(1) of the CWA, NPDES permit actions for new sources are subject to NEPA (40 CFR Part 6, Subpart F). Therefore, EPA would issue a ROD before the final permit action.

      EPA is the NPDES permitting authority in Alaska. The Alaska Department of Environmental Conservation (ADEC), pursuant to Section 401 of the CWA, must provide certification to EPA that the discharge would comply with any applicable state water quality standards. The ADEC certification determines whether wastewater mixing zones are, or are not, permitted.

- **Section 404 Permit Review.** Section 404 of the CWA authorizes the COE to issue permits for the discharge of dredged or fill materials into waters of the United States (described below). EPA, under Section 404(c), has a review authority and may prohibit or withdraw the specification (permitting) of a site upon a determination that the use of the site would have an unacceptable adverse effect on municipal water supplies, shellfish beds and fisheries areas, or recreational areas.
- **Spill Prevention, Control, and Countermeasure (SPCC) Plan.** Section 311 of the CWA establishes requirements relating to discharges or spills of oil or hazardous substances. Discharges or spills of oil in "harmful quantities" are prohibited. EPA has established a requirement for the preparation of an SPCC Plan by facilities that handle substantial quantities of oil (40 CFR 112). A registered engineer must certify the plan.
- **Stormwater Construction and Operation Permit.** Under Section 402(p) of the CWA, EPA has promulgated regulations for control of stormwater runoff. For the Pogo Mine project, these sources would include runoff from roads, laydown areas, the mill and camp sites, and other surface disturbances. The EPA approach to this type of discharge is generally to require implementation of best management practices (BMPs). If an NPDES permit is needed for the project, the stormwater control requirements from the NPDES program may be incorporated into the NPDES permit.
- **Underground Injection Control (UIC) Permit.** The UIC program is authorized by Part C of the Safe Drinking Water Act (SDWA), Public Law 93-523, and Amendments. Injection wells are defined broadly to include boreholes, sumps, dry wells, drain fields, and other subsurface disposal devices used to put fluids into the ground. The Class V category consists of injection wells that are not included in the other classes of wells (e.g., Class I, II, or III). EPA will determine whether any discharge in the proposed project will be covered by a Class V UIC permit.
- **Section 106 Historical and Cultural Resources Protection.** Under Section 106 of the National Historic Preservation Act, as lead federal agency EPA is responsible for ensuring overall protection of historical, cultural, and archaeological sites and resources for the Pogo Mine project. This role would include consultation with the State Historic Preservation Office (SHPO) within the ADNR.
- **Hazardous Waste Generator Identification Number.** Under the Resource Conservation and Recovery Act (RCRA), an entity that generates hazardous wastes must register and receive an identification number before commencing operations.

U.S. Army Corps of Engineers (COE)

The COE is a cooperating agency with EPA for the Pogo Mine project EIS.

- Section 404 Dredge and Fill Permit
- Section 106 Historical and Cultural Resources Protection
  - **Section 404 Dredge and Fill Permit.** Section 404 of the CWA authorizes the COE to issue permits for discharge of dredged or fill material into waters of the United States, including wetlands. The CWA prohibits such a discharge, except pursuant to a Section 404 Permit. To the degree that they affect "waters of the United States,"

various activities undertaken in connection with mining operations might require a Section 404 Permit (including road or bridge construction, construction of dams for tailings storage, water storage dams, and stream diversion structures).

The COE is responsible for determining that the proposed project is in compliance with Section 404(b)(1) guidelines (40 CFR 203). Under Section 404(c), EPA has review authority over the COE 404 Permit decisions.

- **Section 106 Historical and Cultural Resources Protection.** Under Section 106 of the National Historic Preservation Act, the COE is responsible for ensuring protection of historical, cultural, and archaeological sites and resources for the Pogo Mine project within the COE's permit area. This role would include consultation with the SHPO.

National Marine Fisheries Service (NMFS)

- Threatened and Endangered Species Act (ESA) Consultation (Section 7)
- Essential Fish Habitat
- Fish and Wildlife Coordination
  - **Threatened and Endangered Species Consultation (Section 7).** EPA must conduct an ESA Section 7 consultation with the National Marine Fisheries Service (NMFS) regarding any threatened or endangered species under its jurisdiction that may be affected by the proposed project. The level of required informal or formal consultation would depend on whether listed species occur in the project area, and, if so, whether they likely would be affected by the proposed project. If listed species occur in the area and they likely would be affected, EPA and NMFS would undergo the formal consultation process. This is typically an involved process that results in measures designed to minimize the impact of the project on listed species.
  - **Essential Fish Habitat.** In a similar manner, EPA must consult with NMFS concerning any action that might adversely affect essential fish habitat (EFH). EFH includes habitats necessary to a species for spawning, breeding, feeding, or growth to maturity. EPA will provide NMFS with an EFH assessment.
  - **Fish and Wildlife Coordination.** The NMFS also provides technical expertise and makes comments and recommendations to federal agencies via the Fish and Wildlife Coordination Act (United States Code [USC], Title 16, Section 661 *et seq.*).

U.S. Fish and Wildlife Service (USFWS)

- Threatened and Endangered Species Consultation (Section 7)
- Bald Eagle Protection Act Clearance
- Migratory Bird Protection
- Fish and Wildlife Coordination
  - **Threatened and Endangered Species Consultation (Section 7).** EPA must conduct an ESA Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) regarding any threatened or endangered species under its jurisdiction that may be affected by the proposed project. The level of required informal or formal consultation would depend on whether listed species occur in the project area, and, if so, whether they likely would be affected by the proposed project. If listed species occur in the area and they likely would be affected, EPA and USFWS would undergo the formal consultation process. This can be, but is not always, an involved process.

- ✦ **Bald Eagle Protection.** The USFWS implements provisions of the Bald Eagle Protection Act by ensuring that development does not affect nest trees.
- ✦ **Migratory Bird Protection.** The USFWS implements provisions of the Migratory Bird Protection Act.
- ✦ **Fish and Wildlife Coordination.** The USFWS also provides technical expertise and makes comments and recommendations to federal agencies via the Fish and Wildlife Coordination Act (16 USC 661 *et seq.*).

Mine Safety and Health Administration (MSHA)

- Mine Identification Number
- Miner Training and Retraining Plan Approval
    - ✦ **Mine Identification Number.** Because worker health and safety aspects of the Pogo Mine Project would be regulated by federal health and safety standards, the Applicant must obtain a Mine Identification Number from the Mine Safety and Health Administration (MSHA). Agency representatives would make routine inspections of the operation and also would be involved in educational and safety training programs. The Pogo Mine project would be responsible to provide MSHA with reports of accidents, injuries, occupational diseases, and related data.
    - ✦ **Miner Training and Retraining Plan Approval.** MSHA must approve specific programs for the education, training, and retraining of all employees.

Bureau of Alcohol, Tobacco, and Firearms (BATF)

- License to Transport Explosives
- Permit and License for Use of Explosives
    - ✦ **License to Transport Explosives.** Interstate transportation of explosives is regulated by the Bureau of Alcohol, Tobacco, and Firearms (BATF). The Pogo Mine project or its explosive supplier would need to obtain a license for transport of such explosives to the site.
    - ✦ **Permit and License for Use of Explosives.** BATF also would have to issue an Explosives User Permit to the Pogo Mine project.

Federal Communications Commission (FCC)

- Radio License
    - ✦ **Radio License.** Radio and microwave station authorizations would need to be obtained from the Federal Communications Commission (FCC). A license must be obtained for any two-way radio installations made at the project site.

Federal Aviation Administration (FAA)

- Notice of Landing Area Proposal
- Notice of Controlled Firing Area for Blasting
    - ✦ **Notice of Landing Area Proposal.** An entity proposing to construct a landing area must notify the Federal Aviation Administration (FAA) of the location, length, bearing, and other details of the proposed landing area.
    - ✦ **Notice of Controlled Firing Area for Blasting.** Entities engaged in the use of explosives also must notify the FAA of the location of such areas.

U.S. Coast Guard (USCG)

- Bridge Construction Permit Across Navigable Waters
  - ✦ **Construction Permit for a Bridge Across Navigable Waters.** To ensure safe navigability of waterways, construction of a bridge across navigable waters must be approved by the U.S. Coast Guard (USCG).

State of Alaska

The State of Alaska is a cooperating agency with EPA for the Pogo Mine project EIS.

Alaska Department of Natural Resources (ADNR)

- Plan of Operations Approval
- Upland Mining Lease
- Millsite Lease
- Lease of Other State Lands
- Miscellaneous Land Use Permit
- Road Right-of-Way
- Joint Pipeline Office Approval
- Power Line Right-of-Way
- Certificate of Approval to Construct a Dam
- Certificate of Approval to Operate a Dam
- Temporary Water Use Permit
- Permit to Appropriate Water
- Material Sale
- Burn Permit
- Cultural Resources Authorizations
- Mining License
- Fish Passage
- Fish Habitat Permit
  - ✦ **Plan of Operations Approval.** ADNR must approve the plan of operations for a mining project on state lands. The plan of operations includes the project description, Reclamation Plan, Monitoring Plan, Transportation Plan, and any road maintenance agreements. Reclamation Plan approval includes a mandatory bonding provision, prohibits undue and unnecessary degradation, and contains performance standards requiring that lands be returned to a stable condition. The Reclamation Plan would apply to the upland mining and millsite lease areas.
  - ✦ **Upland Mining Lease.** Prior to initiation of production, the holder of a mining claim or group of claims may request a lease for the purposes of producing minerals from the claims.

- **Millsite Lease.** Use of state lands for other than temporary purposes requires a lease. This lease requirement includes use of lands for mill sites or other mine support purposes.
- **Lease of Other State Lands.** The Applicant is considering a lease of state lands near the Richardson Highway for purposes of a bus terminal, shop, storage, road maintenance equipment storage, and parking. If issued, this lease would require a separate Reclamation Plan, insurance, and bonding.
- **Miscellaneous Land Use Permit.** Any winter road use during project development would be authorized under a separate permit and would require a separate bond and Reclamation Plan.
- **Access Road Right-of-Way.** A grant of right-of-way (ROW) is required across state lands for roads, power lines, and pipelines. If a road ROW were granted, the Applicant and ADNR would enter into a road maintenance agreement.
- **Joint Pipeline Office Approval.** Any activities that cross the Trans-Alaska Pipeline System (TAPS), such as the all-season road or winter road ground access options, would require authorization from the Federal/State Joint Pipeline Office.
- **Power Line Right-of-Way.** A grant of ROW is required across state lands for power lines.
- **Certificates of Approval to Construct a Dam.** A Certificate of Approval to Construct a Dam is required for the construction, enlargement, alteration, repair (other than routine maintenance), or abandonment of a dam pursuant to Alaska Administrative Code (AAC), Title 11, Chapter 93. Dam construction would be subject to design and supervision by an Alaska registered professional engineer.
- **Certificate of Approval to Operate a Dam.** A Certificate of Approval to Operate a Dam would be issued by the Division of Mining, Land, and Water after completion of construction and approval of the completion report, as-built drawings, Operations and Maintenance Manual, and if required, an Emergency Action Plan.
- **Temporary Water Use Permit.** Temporary uses of a significant volume of water, for up to 5 years, requires a Temporary Water Use Permit.
- **Permit to Appropriate Water.** Appropriation of a significant amount of water on other than a temporary basis requires authorization by a Water Rights Permit. A Water Right is a property right for the use of public surface and subsurface waters. The right becomes attached to the land where the water is used. Once use of the appropriated water has been fully developed and demonstrated, a Certificate of Appropriation securing the holder's rights to the water would be issued. This certificate is not automatic; it depends on actual use of the full amount of water and compliance with all permit conditions.
- **Material Sale.** Material sales (Alaska Statute [AS] 38.05.020) would be used for gravel borrow materials not located within the boundary of the millsite lease or a road ROW. Each site would require a Development Plan that addresses the handling of timber and slash, a bond, and a Reclamation Plan.
- **Burn Permit.** Anyone wishing to burn outside an incinerator is required to obtain a Burn Permit (AS 41.15.050 and 41.15.060) during the burn season between May 1 and September 30. Whereas the ADEC Permit to Open Burn primarily is concerned with air quality, this ADNR permit primarily is concerned with fire control.

- **Cultural Resources Authorizations.** A Field Archaeology Permit must be issued from the SHPO for archaeological field work on state lands. The SHPO also would be consulted by the COE as it exercises its National Historic Preservation Act Section 106 responsibilities. The SHPO must concur that cultural resources would not be adversely affected, or that proper procedures would be used to minimize or mitigate impacts that would occur.
- **Mining License.** A mining license would be required before the mine entered production.
- **Fish Passage.** AS 16.05.840 (Fishway Act) requires that an individual or governmental agency notify and obtain authorization from ADNR for activities within or across a stream used by fish if the department determines that such uses or activities could represent an impediment to the efficient passage of fish. Culvert installation, stream realignment or diversion, dams, low-water crossings, and construction, placement, deposition, or removal of any material or structure below ordinary high water all require approval from ADNR. Construction activities also must be coordinated with critical spawning periods of anadromous fish.
- **Fish Habitat Permit (Anadromous Fish Act).** AS 16.05.870 (Anadromous Fish Act) requires that an individual or governmental agency provide prior notification and obtain approval 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. All activities within or across a specified anadromous water body and all instream activities affecting a specified anadromous water body require approval from ADNR.

Alaska Department of Environmental Conservation (ADEC)

- Certificate of Reasonable Assurance for Section 402 and 404 Permits
- Waste Disposal Permits
- Air Quality Control Permit to Construct and to Operate
- Air Quality Permit to Open Burn
- Approval to Construct and Operate a Public Water Supply System
- Plan Review for Non-Domestic Wastewater Treatment System
- Non-Domestic Wastewater Disposal Permit
- Plan Review and Construction Approval for Domestic Sewage System
- SPCC Plan Review Approval
- Oil Discharge Prevention and Contingency Plan (winter road option only)
- Storm Water Discharge Pollution Prevention Plan
- Food Sanitation Permit
  - **Certificate of Reasonable Assurance for Section 402 and 404 Permits.** Activities involving discharge of wastewater or fill material into waters of the United States are not only governed by the terms and conditions of a CWA Section 402 NPDES Permit from EPA and a CWA Section 404 Permit from the COE, but also require a Certificate of Reasonable Assurance from the State of Alaska. These certificates can only be issued if ADEC can state that the proposed activity would comply with

Section 401 of the CWA and that any discharge would comply with applicable state water quality standards.

- **Waste Disposal Permits.** A waste disposal permit is required to establish, modify, or operate a waste disposal facility. Public notice is required for this permit, and permits are issued for periods of as long as 5 years. For the Pogo project, definitions of solid waste include the dry stack tailings pile; the tailings with cyanide residue to be redeposited underground; potentially acid-generating waste rock, which could present an environmental problem associated with management of the waste material; and disposal of construction debris and garbage. A soil absorption system also would be covered, and domestic solid waste may be covered.
- **Air Quality Control Permit to Construct and to Operate.** The construction, modification, and operation of mining facilities that produce air contaminant emissions require a state Air Quality Control Permit to Construct and a separate Air Quality Control Permit to Operate. The determination to require a permit is based on the source location, total emissions, and changes in emissions for sources specified in 18 AAC 50.300(a). Generally, air quality must be maintained at the lowest practical concentrations of contaminants specified in the Ambient Air Quality Standards of 18 AAC 50.020(a) (suspended particulates, sulfur oxides, carbon monoxide, ozone, nitrogen dioxide, reduced sulfur compounds, and lead). An Applicant must submit an application and supplemental information as required by 18 AAC 50.3000(b). Permits are issued for a maximum 5-year period, renewable by the same procedure as the original application.
- **Air Quality Permit to Open Burn.** If the Applicant were to contemplate open burning of cleared vegetation or non-commercial timber, a separate Air Quality Permit to Open Burn would be required. Whereas the ADNR Burn Permit primarily is concerned with fire control, this ADEC permit primarily is concerned with air quality.
- **Approval to Construct and Operate a Public Water Supply System.** Prior to start of construction, ADEC must approve, in writing, detailed engineering reports, plans, and specifications for the construction, alteration, or modification of a public water system. Once construction has been completed, ADEC must approve operation of a public water system.
- **Plan Review for Non-Domestic Wastewater Treatment System.** Plans for disposal of wastewater from milling operations and other non-domestic wastewater sources are required as part of an application for a state Wastewater Disposal Permit and an NPDES Permit. ADEC would review an NPDES application for adequacy under its Section 401 Certificate of Reasonable Assurance authority. ADEC must review and approve treatment facility plans.
- **Non-Domestic Wastewater Disposal Permit.** ADEC also must authorize the discharge of wastewater into or upon all waters and land surfaces of the state. If injection wells are part of the Wastewater Disposal Plan, the requirements of EPA's Underground Injection Control Class V Wells must be met in the state Non-domestic Wastewater Permit.
- **Plan Review and Construction Approval for Domestic Sewage System.** The construction and operation of facilities that collect, treat, and dispose of wastewater is governed by a plan review to ensure that minimum standards are applied. Plans for disposal of gray water, sewage, or process water must be reviewed prior to construction of facilities that involve subsurface wastewater disposal. Detailed

engineering reports, plans, and specifications must be certified by a registered professional engineer.

- **SPCC Plan Review Approval.** ADEC would use its CWA Section 401 certification authority to review the SPCC Plan required by EPA for storage of large quantities of oil.
- **Oil Discharge Prevention and Contingency Plan.** Approval of an oil discharge contingency plan is required prior to commencement of operation of vessels and oil barges on state waters, or for oil terminal facilities capable of storing 10,000 barrels or more. These contingency plans are reviewed every 3 years. For the Pogo Mine project, this plan would be required only if the winter road access option that would require large fuel storage volumes at the mine site were selected.
- **Storm Water Discharge Pollution Prevention Plan.** ADEC would use its CWA Section 401 certification authority to review the Storm Water Discharge Pollution Prevention Plans required by EPA for construction activities that would disturb the ground surface and potentially lead to runoff pollution.
- **Food Sanitation Permit.** Construction and operation of permanent, temporary, and mobile food services, regardless of whether there is a charge for food, are governed by the Alaska Eating and Drinking Establishment Regulations, which include provisions for plan review and issuance of a food service permit.

Department of Transportation and Public Facilities (ADOT/PF)

- Driveway Permit
  - **Driveway Permit.** ADOT/PF uses state highway standards to review and approve plans for modifying, realigning, or constructing state roads, including driveways or roadways entering them.

1.9 Existing Permits and Approvals

To date, a number of permits have been obtained by the Applicant during the course of surface and subsurface exploration. The major permits, their nature, and where to find additional information about them are described below.

Army Corps of Engineers (COE) – Leroy Phillips, Army Corps of Engineers, P.O. Box 6898, Elmendorf AFB, AK 99506-6898; Phone: (907) 753-2828

- CWA Section 404 (wetlands) permit to fill 14 acres of wetlands to construct access roads and rock storage pads (March 4, 1999)

Environmental Protection Agency (EPA) – Cindi Godsey, 222 West 7th Avenue, Anchorage, AK 99513; Phone: (907) 271-6561

- NPDES Storm Water Construction General Permit coverage notice (November 2, 1999)

Alaska Department of Natural Resources (ADNR) – Steve McGroarty, Division of Mining, Land and Water Management, 3700 Airport Way, Fairbanks, AK 99709-4699; Phone: (907) 451-2795

- Miscellaneous Land Use Permit for use of the Goodpaster Winter Trail (December 22, 1997)

- Approved Plan of Operations and Reclamation Plan for Advanced Exploration (underground) (March 2, 1999)

Alaska Department of Environmental Conservation (ADEC) – Pete McGee, Watershed Management, 610 University Avenue, Fairbanks, AK 99709; Phone: (907) 451-2101

- Wastewater Disposal Permit to discharge treated mine drainage by way of an underground injection well (March 1, 1999)

Alaska Department of Fish and Game (ADFG) – Jack Winters, Habitat Division, 1300 College Road, Fairbanks, AK 99701; Phone: (907) 459-7289

- Several Fish Habitat Permits for activities potentially affecting anadromous fish streams and fish passage (equipment crossing streams, water withdrawal, ice bridges)

1.10 EIS Structure

The format and content of this EIS follows the CEQ regulations at 40 CFR 1502 and EPA's regulations at 40 CFR 6 Subpart F. The purpose of the EIS is to evaluate the overall direct, indirect, and cumulative impacts of the project alternatives on the mine area as well as adjacent areas. The structure of the EIS accomplishes this evaluation in a four-step process.

First, in Chapter 2 (Alternatives), the project options and alternatives that have been considered by EPA are discussed. The chapter describes how scoping issues were identified, explains how evaluation criteria were developed and how options were screened, and discusses how the alternatives were identified and evaluated. It describes the Applicant's Proposed Project as well as the alternatives, including the No Action Alternative.

In the second step, Chapter 3 (Affected Environment) describes the environment of the project area as it exists today, *before* the project is developed. This description provides a basis against which project development impacts may be measured.

In the third step, Chapter 4 (Environmental Consequences) describes the environmental impacts of the Proposed Action and alternatives, determines the degree of those impacts on the human environment, and discusses whether those impacts could be mitigated. Figuratively, the EIS superimposes the project description (Chapter 2) on the existing environment (Chapter 3) to determine whether impacts would occur (Chapter 4).

Chapter 2 Alternatives

2.1 Introduction

An important part of the EIS process is developing options and alternatives to the Applicant's proposed project that address the issues identified by the public and agencies during scoping. This chapter explains how that was done.

It is important in reviewing this EIS to understand the relationship between the terms "component," "option," and "alternative."

- **Component.** A complete mining project such as the Pogo Mine has several components, each a necessary part of an entire viable project; for example, the mill process, the tailings disposal system, and how the project location is accessed.
- **Option.** For each component, there are one or more options, or choices; for example, for the access component there are all-season road options (Shaw Creek Hillside and South Ridge) and winter road/trail options (Shaw Creek Flats and the Goodpaster Valley).
- **Alternative.** An alternative is a set of options (one for each component) that constitutes an entire functioning project; for example, one mill process, one tailings disposal location, one airstrip location, and one surface access route.

Section 2.2 (No Action Alternative) describes what would happen in the project area if no action were taken and the Pogo Mine project did not go forward.

Section 2.3 (Applicant's Proposed Project) describes the Applicant's Proposed Project in relative detail so readers can understand what has been proposed.

Section 2.4 (Issues, Options, and Screening) describes the three-step process by which: the issues were identified; options other than those proposed by the Applicant were developed to address those issues; and how screening criteria were identified and the options screened.

Section 2.5 (Action Alternatives Identification) describes how the options and sub-options remaining after screening were grouped into full project alternatives to be assessed in detail in Chapter 4 (Environmental Consequences) to determine environmental impacts.

2.2 No Action Alternative

In the No Action Alternative, the Pogo Mine project would not be developed. This alternative may be used as a baseline for comparison with the action alternatives to determine impacts.

For many issues raised during scoping (e.g., water quality, air quality, and fish), the No Action Alternative likely would mean no changes from the present condition in the reasonably foreseeable future because none of the potential impacts from development of the Pogo Mine project would occur and because there are no other factors on the horizon that might affect these resources.

For other issues, however (e.g., socioeconomics and industrial and commercial uses), changes could occur because factors unrelated to the Pogo project development could influence them. For example, deployment of the National Missile Defense System (NMDS) definitely would change the present socioeconomic picture in the Delta Junction area with respect to population, jobs, and pressures on existing services, whether or not the Pogo mine were developed. Also, the 5-year harvesting plan of the Division of Forestry (DOF) likely would be implemented, and thus, the present status of timber access and logged areas would be affected. Therefore, in Chapter 4 (Environmental Consequences), there is a discussion of what the No Action Alternative would mean with respect to each resource.

The No Action Alternative would result from denial of at least one, or perhaps more, of the federal or state permits necessary for project development. It also could result if the Applicant chose not to develop the project because of a drop in the price of gold, or because the Applicant chose to direct its mine development resources elsewhere.

2.3 Applicant's Proposed Project

This section describes the Applicant's Proposed Project. A more detailed description may be found in the Applicant's *Pogo Project Plan of Operations* (Teck-Pogo Inc., 2002a), *Pogo Project Plan of Operations Supplement* (Teck-Pogo Inc., 2002i), and *Pogo Project Right-of-Way Application* (Teck-Pogo Inc., 2002j).

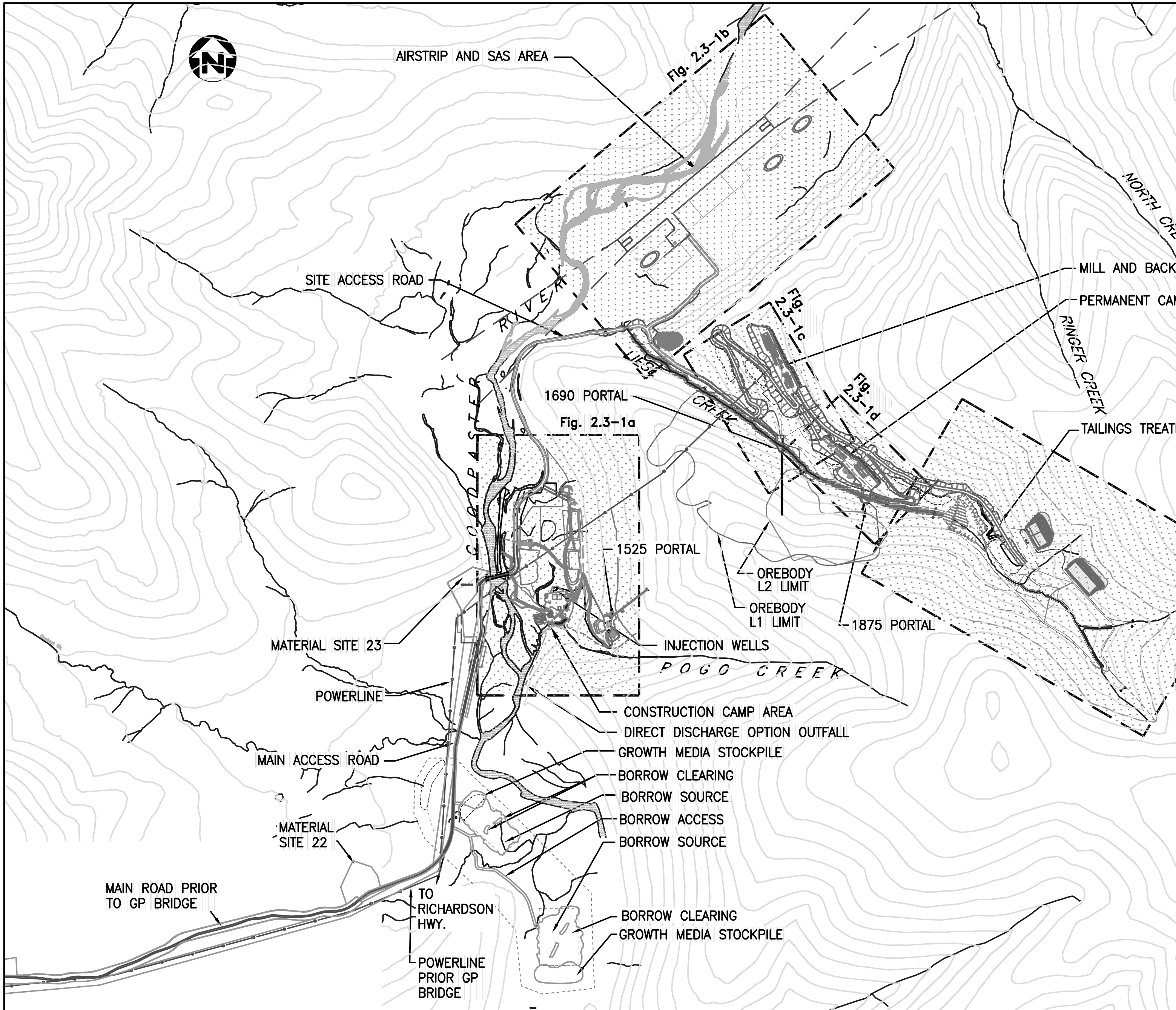
2.3.1 Project Design Criteria

The Pogo Mine project design criteria:

Operating period		24 hours per day; 365 days per year
Mining rate		Same as milling criteria
Milling rate:	Start-up production	Average 2,500 tpd
	Eventual production	Average 3,500 tpd
Milling process		Grinding, gravity separation, flotation concentration, and cyanide vat leaching
Tailings storage (surface and underground)		11 million tons
Development rock generated during mine life		1.9 million tons
Current projected mine life @ 2,500 tpd		11 years
Annual gold production		375,000 to 500,000 oz
Construction employees for start-up facilities		700
Operating employees		288 @ 2,500 tpd 360 @ 3,500 tpd
Energy requirements for mine operations		10 MW @ 2,500 tpd 14 MW @ 3,500 tpd
Annual operating fuel usage:	Diesel	786,000 gals @ 2,500 tpd 1,300,000 gals @ 3,500 tpd
	Propane	930,000 gals @ 2,500 tpd 1,850,000 gals @ 3,500 tpd
Annual operational non-fuel supplies		27,000 tons @ 2,500 tpd 42,000 tons @ 3,500 tpd

2.3.2 General Mine Site Plan

Figure 2.3-1 presents the general mine site plan for the Applicant's proposed all-season road option. Subsequent figures present the existing mine portal site plan (2.3-1 a), airstrip and associated facilities (2.3-1 b), Liese Creek Valley mill site plan (2.3-1 c), Liese Creek Valley camp and shop plan (2.3-1 d), and the Liese Creek Valley recycle tailings pond (RTP) and tailing treatment facility plan (2.3-1 e).



Pogo Mine EIS

Figure 2.3-1
General Mine Site Plan

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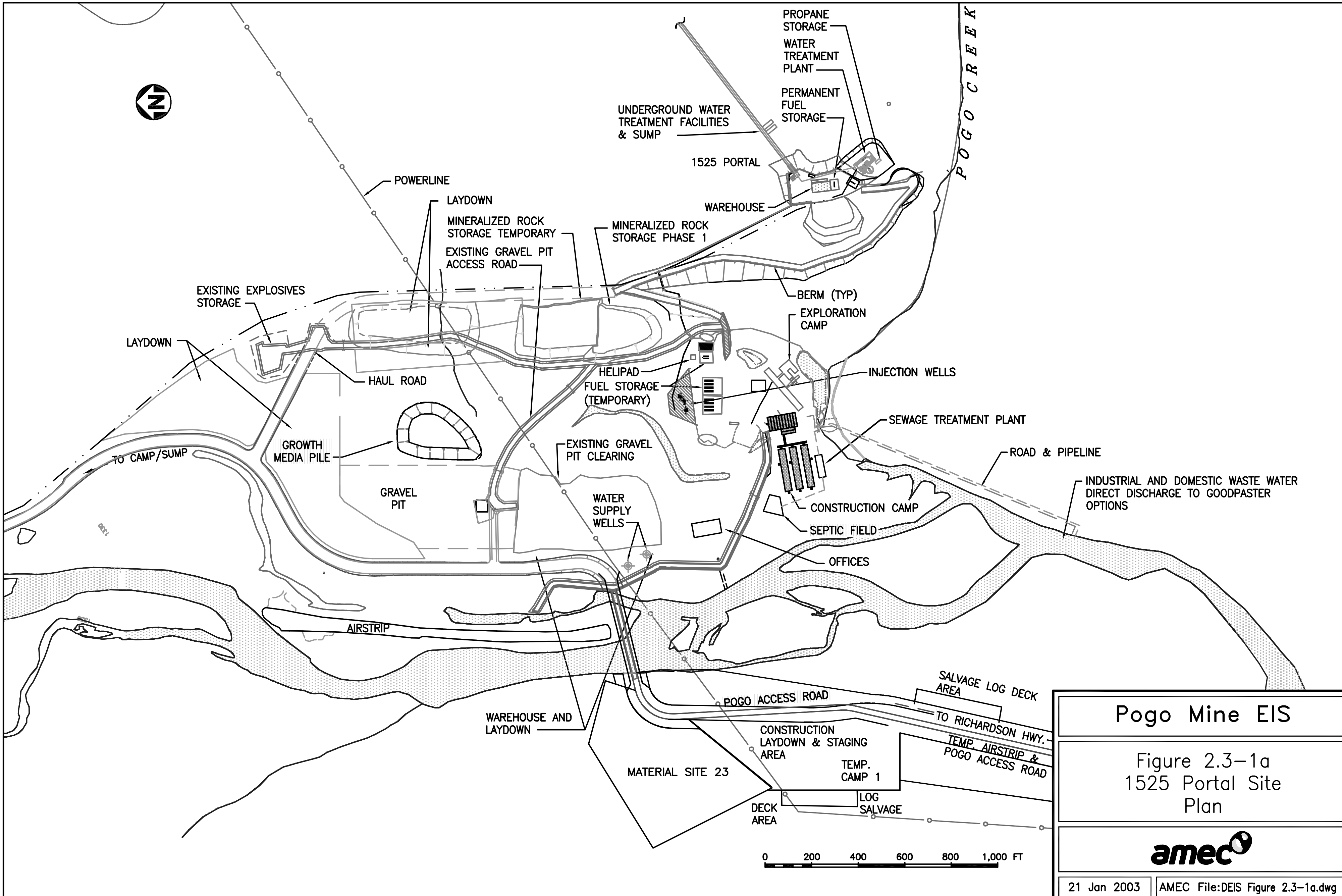

Pogo Mine EIS

Figure 2.3-1a
1525 Portal Site
Plan

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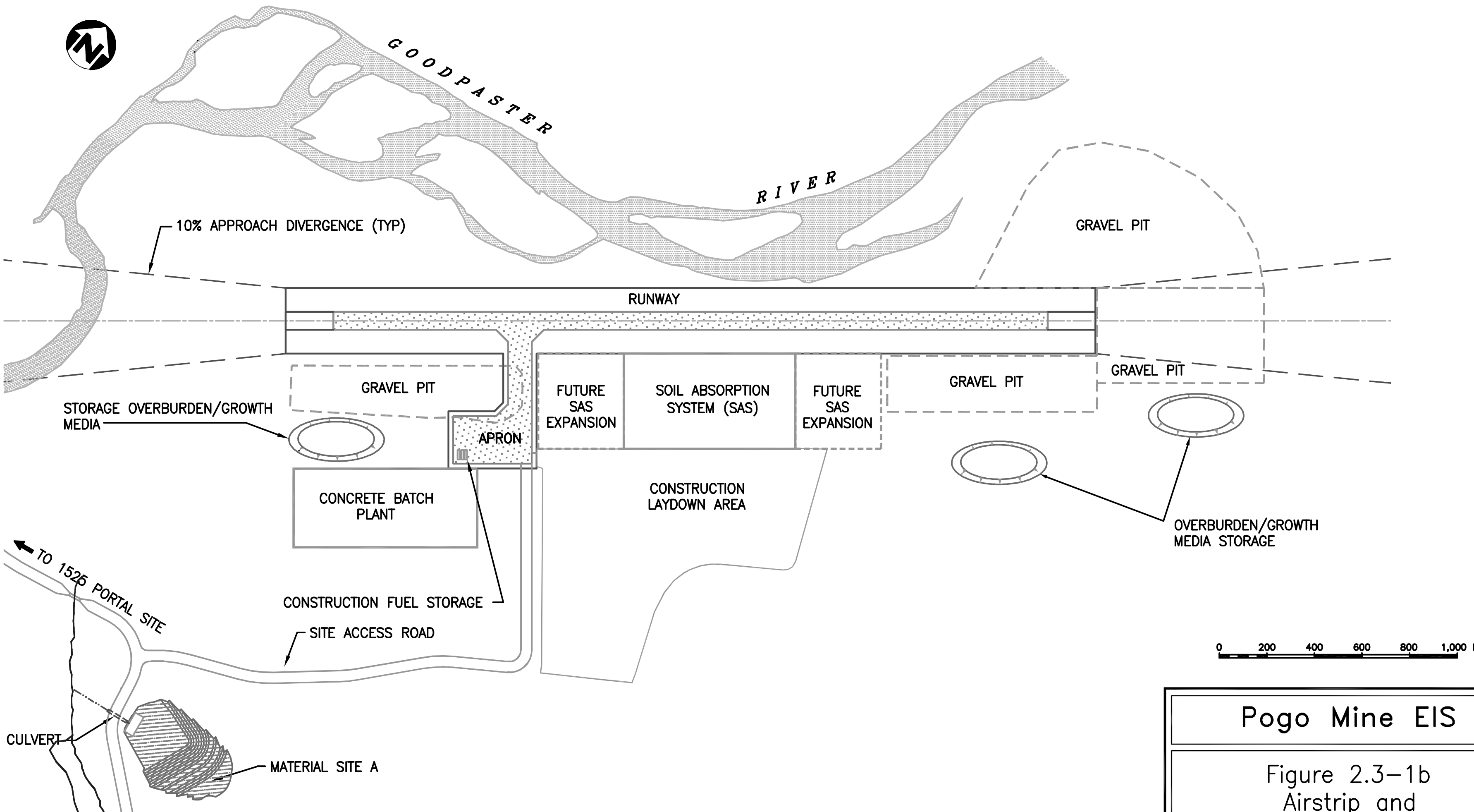

Pogo Mine EIS

Figure 2.3–1b
Airstrip and
Associated Facilities

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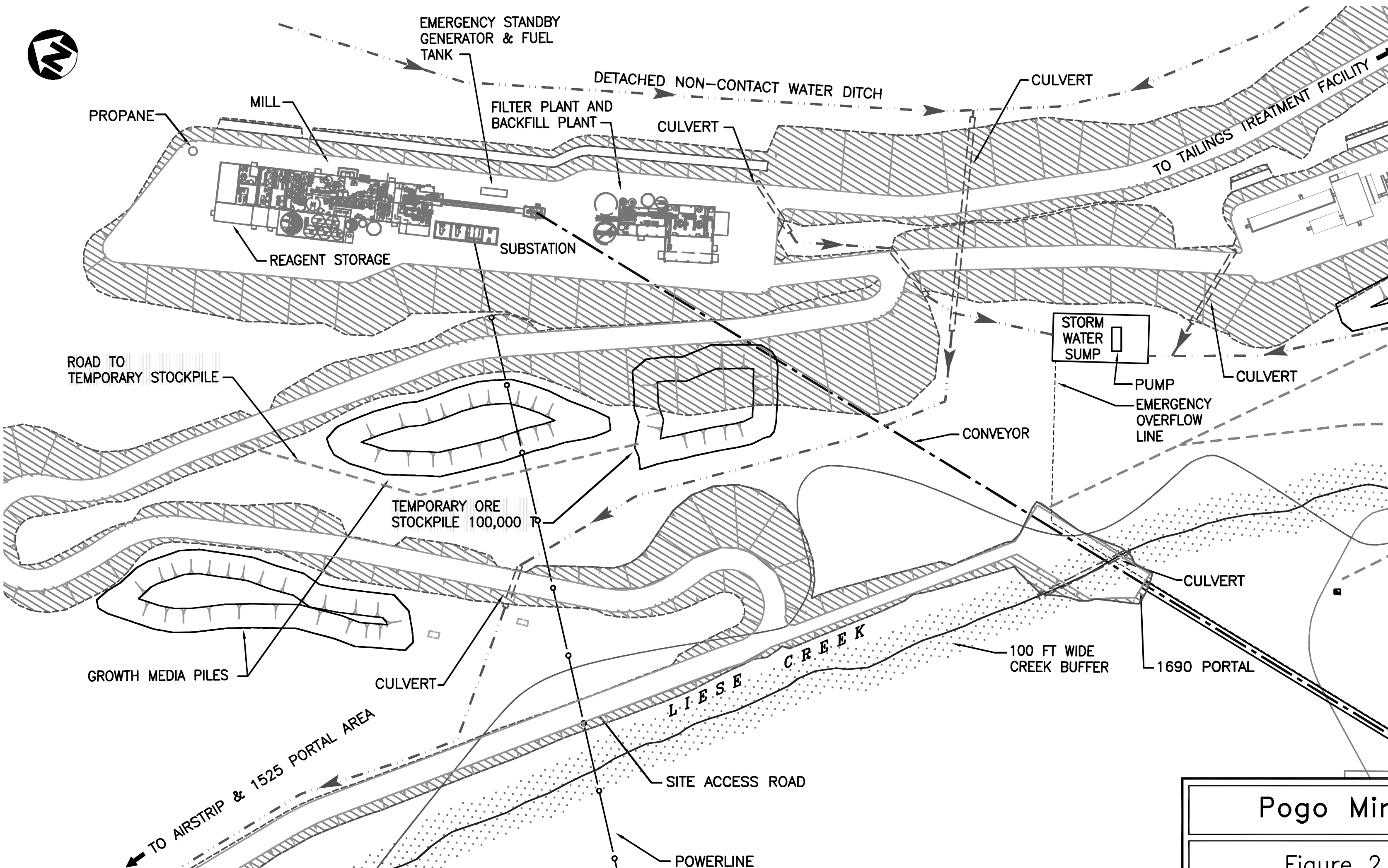

Pogo Mine EIS

Figure 2.3–1c
Liese Creek Valley Mill Site Plan

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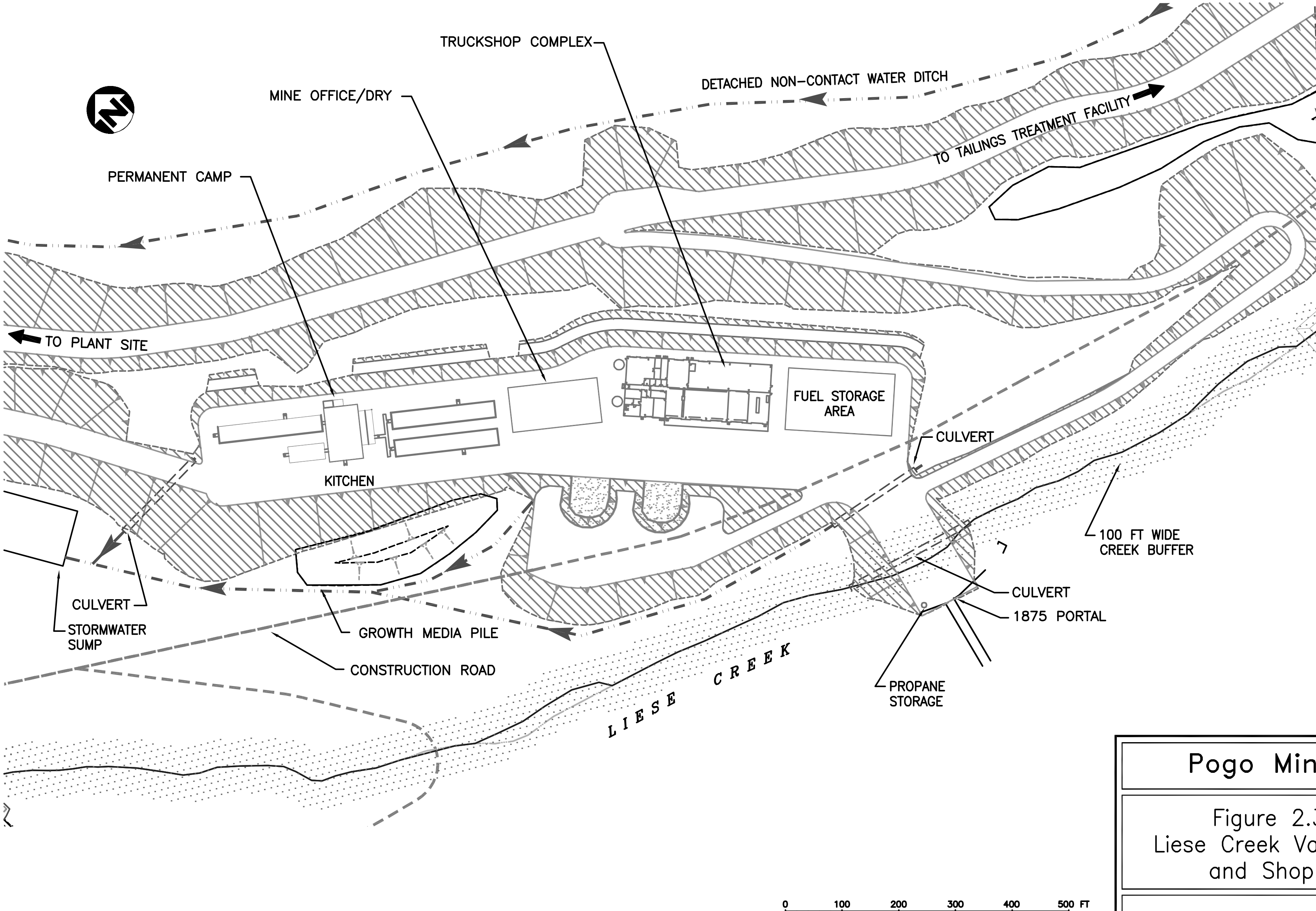

Pogo Mine EIS

Figure 2.3–1d
Liese Creek Valley Camp and Shop Plan

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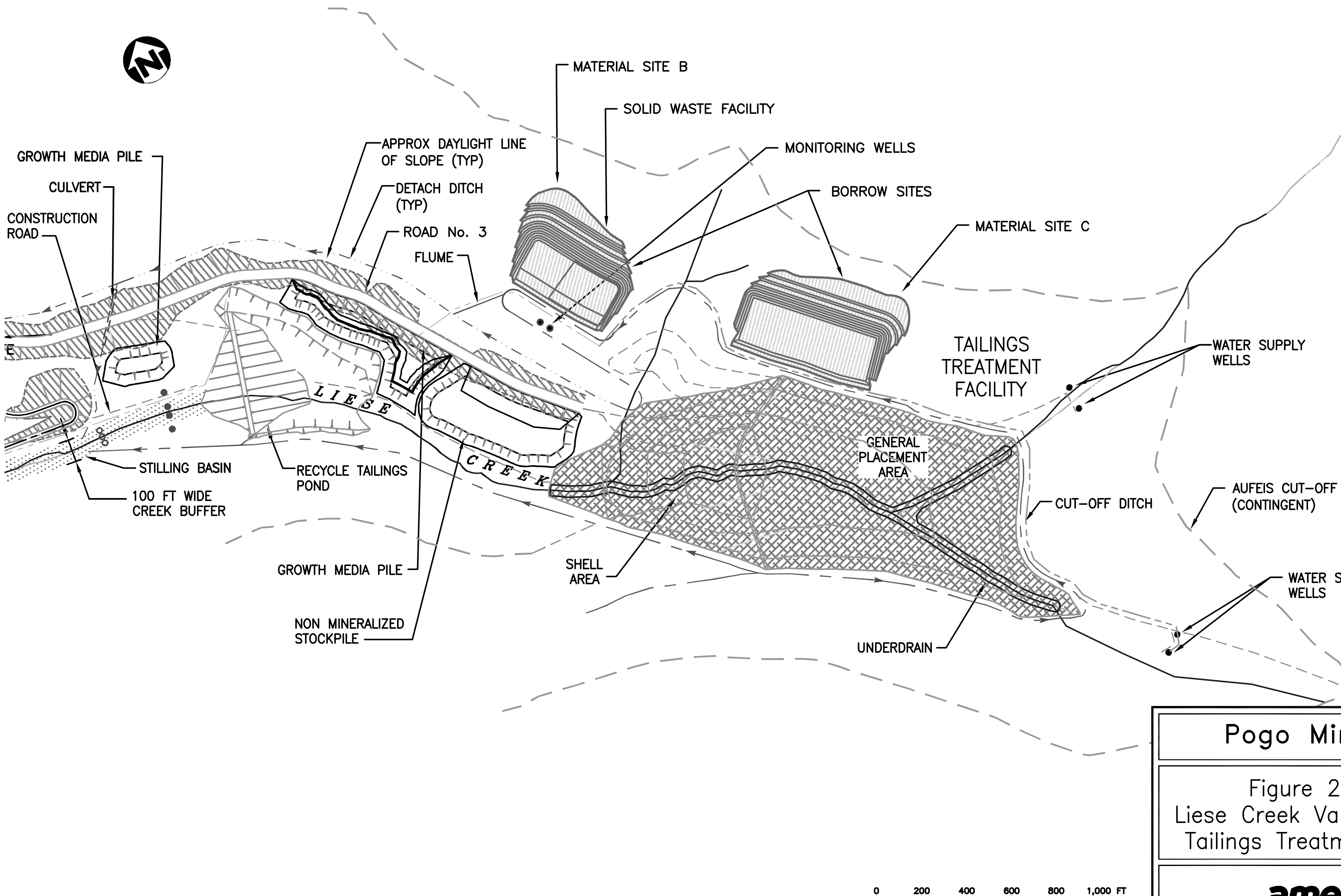

Pogo Mine EIS

Figure 2.3-1e
Liese Creek Valley RTP and Tailings Treatment Facility

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21 Jan 2003 | AMEC File:DEIS Figure 2.3-1e.dwg

2.3.3 Access

The Applicant proposes two modes of access to the mine site: surface and air.

Surface Access

The Shaw Creek Hillside option would be a 49.5-mile, two-lane, all-season road (Figure 2.3-2). It would begin at the end of the existing approximately 2.1-mile-long Shaw Creek Road on the west side of Shaw Creek, and cross the TAPS approximately 4.5 miles from the Richardson Highway. It would proceed up the northwest side of the Shaw Creek Valley for a distance of approximately 26 miles. It then would cross Shaw Creek and climb 18 miles over the divide into the Goodpaster River Valley and cross the river to the mine site. The highest road elevation would be 3,300 feet (ft); the lowest 970 ft.

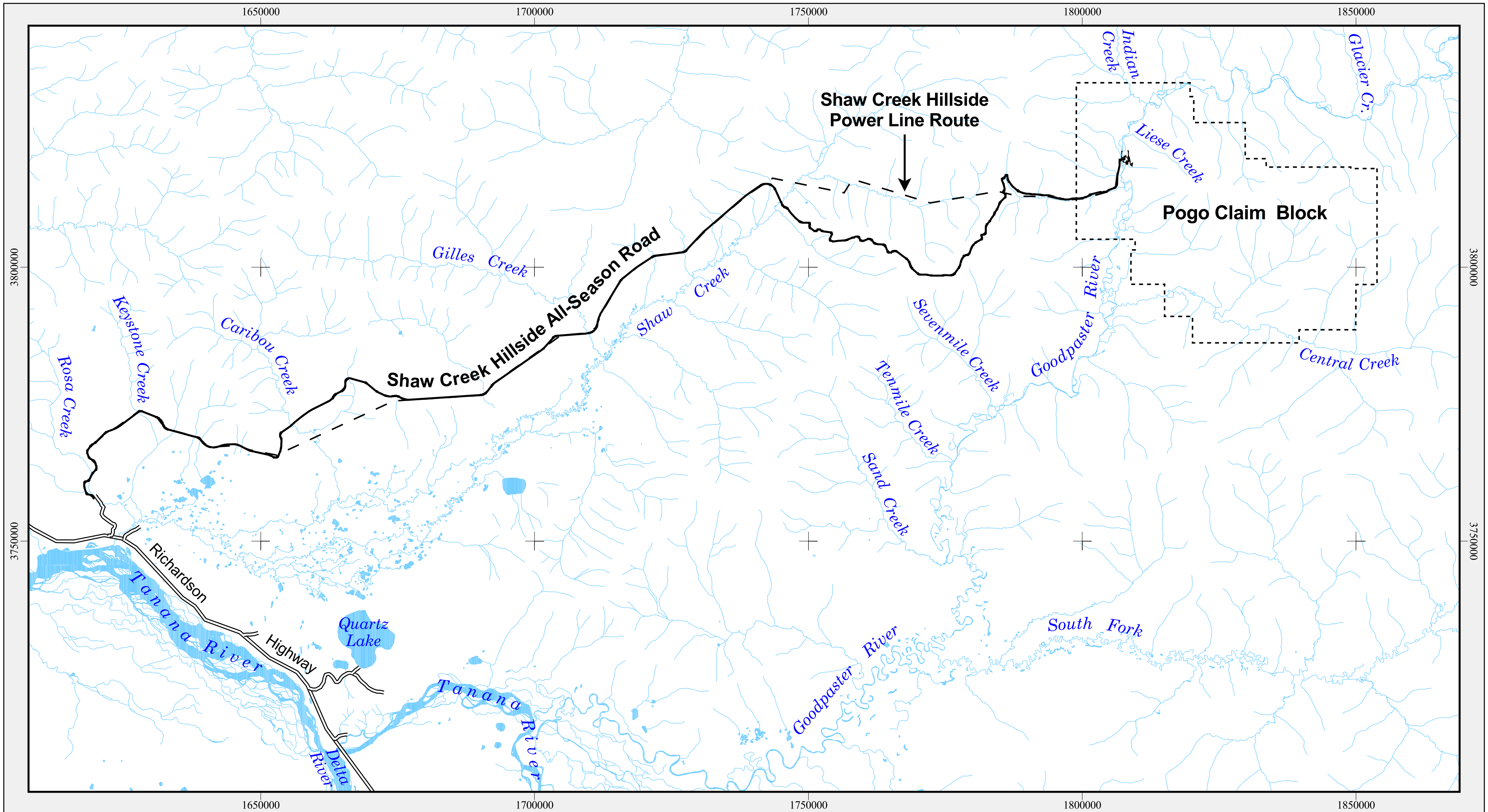
The road would meet or exceed American Association of State Highway and Transportation Officials (AASHTO) standards as a resource development road. Because the road would transect the TVSF, the design criteria have been developed to meet or exceed the proposed DOF northern region forest road standards for moderate-to-heavy, long-term, year-round use (Table 2.3-1).

The road would have either a 24-ft surface, or in steep areas an 18-ft surface with a safety berm. Conventional cut-and-fill road construction methods would be used on the majority of the road alignment. Limited areas traversing permafrost, wetlands, or both would use a thick (4 ft to 6 ft) fill section placed over geotextile fabric. Segments between Shaw Creek and the Goodpaster River would require blasting and/or ripping of bedrock.

The road surface would be gravel or crushed rock. Approximately 1.3 million cubic yards (cu yd) of material would be moved to complete road construction. An estimated 250,000 cu yd of classified material and 220,000 cu yd of rock for road surfacing would be required from 23 potential material sites.

The road would have a maximum grade of 7 percent, with limited short grades of 8 percent. There would be two long grades of 5 to 7 percent; one of approximately 4.3 miles climbing from Shaw Creek to the Shaw Creek and Goodpaster River divide, and one of approximately 3.2 miles descending to the Goodpaster River. There would be no turnouts, but there would be truck safety run-outs on the two major grades. Roadside berms would be installed at all bridges, at sharp curves on steep grades, and where the road passes bodies of water deeper than 3 ft. Corrugated metal pipe drainage culverts would be installed at all drainage crossings. The road would be designed for a speed of 35 miles per hour. Radio contact would be maintained between all vehicles and mine security, and traffic would be controlled to avoid interference at one-lane sections.

Six single-span, single-lane bridges between 60 and 85 ft long would be required across five creeks: Rosa (two crossings), Keystone, Caribou, Gilles, and Shaw. The Goodpaster River crossing would be a six-span, single-lane bridge, 390 ft long. Bridges would have a design capacity of approximately 100 tons, with a maximum axle load rating of 60 tons.



Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 2.3-2 Applicant's Proposed Shaw Creek Hillside All-Season Road and Power Line Routes

map prepared by: ABR inc. environmental research & services

24 July 2002 | ABR File: Pogo_PDEIS_Chapter2.apr

Table 2.3-1 DOF and Applicant Access Road Design Criteria Comparison

Criterion	DOF Criteria[1]	Applicant's Proposed Criteria
Design speed	None given.	35 mph.
Horizontal curve radius	300 ft normal & 100 ft min.	500 ft normal & 300 ft min.
Vertical curve sight distance	None given.	500 ft normal & 350 ft min.
Grade	8% normal & 10% max.	7% maximum except for limited short grades of up to 8%.
Drivable surface	16 ft to 20 ft with rock surface.	24 ft with rock surface, 18 ft with safety berm, single lane as required.
Turnouts	Not required if width is 18 ft+	Not typically required.
Cut & fill	Fill castings 1.5:1 max. Cut slopes at 1:1 max.	Fill 1.5:1 max. 2:1 typical. Cut 1.5:1 max. 2:1 typical. Except bedrock to 0.5:1.
Clearing	5 ft beyond cuts or fills, or min. 35 ft width. Merchantable timber cut and decked ahead of construction.	5 ft beyond cuts or fills, except to toe of fill in wetland areas. Merchantable timber cut and decked ahead of construction.
Grubbing	All debris outside of ditches unless top of stumps under 2 ft of fill.	All debris outside of ditches unless top of stumps under 2 ft of fill. No grubbing in marshy areas.
Debris disposal	If at least 2 ft beyond ditches may be buried under 1 ft of fill or windrowed. If not at least 2 ft beyond ditches, buried under 3 ft of fill.	If at least 2 ft beyond ditches may be buried under 1 ft of fill or windrowed. If not at least 2 ft beyond ditches, buried under 3 ft of fill.
Ditches	1 ft min. depth. 2 ft minimum width. Block ditch on downhill side of culvert inlet where needed.	2 ft min. depth with 3 ft typical. No ditch on down slope side of road where possible. Block ditch on downhill side of culvert inlet where needed.
Culverts[2]	Min. 12 in. dia. installed at or below natural ground line. Installed at natural drainage gradient.	Min. 15 in. dia. installed at or below natural ground line. Installed at natural drainage gradient. Culverts serving major drainage areas are designed appropriately. Cross culverts as needed.

[1] ADNR (2000)
[2] ADOT/PF (2000)

Road construction would proceed from four headings: one at the Goodpaster (east) end; one at the Shaw Creek (west) end; and two in the middle (central). The Goodpaster Winter Trail would be used to stage construction equipment for the east heading. The winter trail in Shaw Creek would be used to establish the two central headings. The TAPS work pad or the existing Shaw Creek Road would be used to establish the west heading. Temporary camps would be established at both the east and central headings. Temporary airstrips would be constructed as wider areas on the road alignment at the east and central headings. Construction would be supported by air until the pioneer all-season road was serviceable.

During mine operations, there would be an estimated annual transport of 30,000 to 40,000 tons of freight to the mine, with negligible tonnage of backhaul. Mine-related large truck traffic would average approximately 5 to 10 round trips per day, 7 days per week, during the day or at night. In addition, there would be an average of approximately eight other daily round trips: periodic personnel change-outs by bus (two per day), Teck-Pogo administrative personnel (three per day), maintenance equipment (two per day), and state and federal agency vehicles (one per day). Overall, mine-related vehicle use would average between 10 and 20 round trips per day.

Depending on the project's particular needs, the number of trucks or other vehicles on a given day could be substantially higher than the average, while on other days there might be few or no trucks or other vehicles. After the road were built, during intense periods of mine construction, traffic would average approximately 50 round trips per day, roughly split between semi-tractor trailers and light vehicles.

For safety reasons, the Applicant proposes that the road be a controlled-access industrial road with traffic restricted to Pogo-related vehicles. There would be a security gate near the end of Shaw Creek Road and another approximately 1 mile east of the TAPS crossing. These gates would be operated and monitored by mine security personnel with the use of remote-controlled video cameras.

A maintenance and staging facility would be developed at material site 3, approximately 2.4 miles from the end of the existing Shaw Creek Road and approximately 750 ft southwest of the TAPS crossing (Figure 2.4-4). The site would be used as a staging area during construction, and then a maintenance shop and a separate employee bus station would be constructed for shift changes. Employees would leave personal vehicles in a fenced, secured area and would be transported to and from the mine by bus.

Shift changes would occur every 4 days, and could be at any time of the day or night. Because of the distance to the mine site, it would take approximately 4 hours from the time buses left the TAPS crossing parking area/bus station with the incoming shift until the buses returned to the parking area/bus station with the outgoing shift. Thus, there would be two peak periods of shift-change traffic on Shaw Creek Road approximately 4 hours apart. During shift changes, up to 180 personal incoming shift vehicles could arrive at the TAPS parking area/bus station, and up to the same number could depart the parking area/bus station approximately 4 hours later.

The proposed Goodpaster River Bridge would be located adjacent to the mine site approximately 68 miles above the mouth of the river (Figure 2.3-1a). The bridge would have six, 65-foot unbroken steel girder sections, for a total length of 390 feet, supported on steel tube piles driven into the unfrozen alluvial gravel. The vertical opening between the proposed bridge and the normal high water level would be 11.2 feet. The horizontal opening would be 65 feet. This design would allow use of pre-fabricated steel girder sections that could be transported over the Goodpaster Winter Trail.

In the preferred winter construction scenario, bridge pile driving and structure erection would take place using equipment set on a grounded ice workpad constructed outward from the west bank. Ice workpad development would be done to allow continued flow under the ice in the main channel. A conventional ice bridge would be constructed at the traditional Goodpaster Winter Trail crossing location, approximately 800 feet downstream from the proposed bridge site, with access to the bridge along the west bank of the river.

If the project approval date would not allow for winter construction, the bridge would be installed by fording the river with appropriate equipment and driving piling in the active river channel. Given past active channel location and normal river levels, two sets of piling would be required in the active channel. Bridge construction activities that would take place in the flowing waters of the river would be completed prior to July 15.

Air Access

For complementary air access to the mine site, the Applicant proposes to construct a 3,000-ft-long by 75-ft-wide gravel airstrip in the Goodpaster Valley just north of the mouth of Liese Creek (Figure 2.3-1). This airstrip would be capable of handling SkyVan, Caribou, DC3, CASA 212, Caravan, and King Air aircraft. Approximately 100 flights per year, or approximately two per week, would be required to support the mine area facilities during operations. Air freight would be flown out of Fairbanks, the public DC6 airstrip near Delta Junction, or a private airstrip 14 miles east of Delta Junction. The airstrip would be maintained for the life of the operation and would be available to provide access for post-closure monitoring.

During initial construction, the airstrip would support operations during the period when Goodpaster Winter Trail access would not be available and the permanent all-season access road not yet completed. Depending on when appropriate permits were received, this period could range from 6 to 12 months. Also during this period, heavy-lift helicopters might be used to transport time-sensitive items that could not be transported by fixed-wing aircraft as discussed below.

Personnel changes during this initial construction period would require transport of up to 130 workers in each direction weekly, needing up to 15 Twin Otter and Cessna Caravan flights per week. Smaller aircraft such as the Cessna 206 and Cessna 207 also would be used and would average approximately ten flights per week. Personnel would be transported from the City of Delta Junction airstrip (D66) and from Fairbanks International Airport.

Fuel and supplies would be transported by DC-3, C-46, Caribou, and SkyVan aircraft. The SkyVan likely would be flown out of an existing private airstrip 14 miles east of Delta Junction; the DC-3 and C-46 would operate out of Fairbanks; and the Caribou would operate out of D66.

Fuel requirements were estimated up to 15,000 gallons per week. If this fuel were flown by the SkyVan, it would require approximately 30 trips per week. Flying out of Fairbanks or D66 with a larger aircraft would require approximately only 15 trips per week. Air freight requirements were estimated at up to 50 tons per week, requiring approximately 15 trips per week with various aircraft.

Thus, aircraft trips during initial construction could total up to between 55 and 70 flights per week, or 8 to 10 per day.

2.3.4 Mining Method

Conventional underground mining techniques would be used to excavate ore from the Pogo deposit. The mine facilities would be designed to extract 2,500 tpd, with the possibility of expansion to 3,500. Three portals would be used to access the mine as listed below (Figure 2.3-1). The number used to refer to each portal represents its elevation above sea level in feet.

- The existing 1525 Portal that was constructed in the Goodpaster Valley during the advanced exploration phase would be used to transport bulk materials underground and would provide intake ventilation.
- A new 1875 Portal in the Liese Creek Valley would provide primary access for men and equipment and also would provide intake ventilation.

- A new 1690 Portal in the Liese Creek Valley would be used primarily for conveyor access to the mine and for exhaust ventilation.

A combination of underground mining methods likely would be used, but most mining would be done by a technique called cut-and-fill mining. This procedure would involve drilling a series of holes in the rock, loading them with explosives, and blasting. The broken rock would be moved out with LHD (load-haul-dump) units, similar to a front-end loader, and 50-ton haul trucks, and taken to ore storage bins. The bins would be fitted with a grizzly (large stationary screen for sorting rock by size) and hydraulic rock breakers to reduce oversize material. From the grizzly, the rock would fall to one of two underground ore bins, which would feed a 42-inch- (in.-) wide, 2,000-ft conveyor that would take the ore to the mill through the 1690 Portal.

After ore removal, the excavated section would be filled with paste backfill, a mixture of cement and tailings material from the milling process. Backfill would provide support so that the adjacent sections of ore could be removed safely. The mining cycle would then repeat.

Air would be provided by intakes at the 1525 and 1875 portals, which would supply approximately 500,000 cubic feet per minute (cfm) of air. Propane units would heat the air in winter. Air would circulate through the mine workings and be exhausted through raises at the 1425 and 2175 levels as well as through the 1690 Portal.

2.3.5 Milling Process

Gold would be recovered from the mined ore in the mill situated in Liese Creek Valley (Figure 2.3-1 and 2.3-1 c). The milling process would consist of grinding the ore to a fine particle size (similar to fine sand), gold recovery through gravity separation, concentrating the remaining gold and sulfide minerals by flotation, and then recovering the gold from the flotation concentrate by cyanide vat leaching. The gravity concentration process would account for approximately 60 percent of gold recovery, with the flotation and cyanide vat leaching process accounting for approximately 40 percent. The gold from both processes would be combined and then melted to produce gold bars.

The milling process for Pogo would isolate the cyanide process from any contact outside the mill. Free cyanide and metallocyanide complexes in the thickened tailings would be oxidized in a cyanide destruction tank by means of a sulfur dioxide (SO_2)/air process. This process would reduce cyanide concentrations in the tailings pore water to less than 2 milligrams per liter (mg/L) of total cyanide (Teck-Pogo Inc., 2002b). Any residual cyanide-bearing tailings material would be placed underground in the mine in a paste (cemented) backfill. Although it would result in 1 to 2 percent lower gold recovery, the gravity/flotation/cyanide vat leach method was selected over the more conventional whole-ore cyanidation approach to minimize the environmental impact. Specifically, the Applicant chose not to use whole-ore cyanidation for the following reasons:

- Whole-ore cyanidation would result in treatment of all the tailings with cyanide. After cyanide destruction these tailings would contain low levels of residual cyanide (less than 2 parts per million [ppm]). Even low levels, however, would present an environmental management issue. Thus, conventional milling was not selected.
- The flotation process selected would concentrate the sulfide- and arsenic-bearing minerals into the gold concentrate. Only this concentrate would be leached for gold recovery and become cyanidation tailings, which then would be incorporated into the

mine paste backfill. As such, the sulfide and arsenic would be returned to their original underground location.

- The flotation and vat leach method would reduce the size of the cyanidation circuit and the quantity of cyanide required on site or present in solution.

The operation of a small cyanidation circuit processing only 250 to 350 tpd of flotation concentrate would allow the separate production and handling of two types of tailings: the tailings from the flotation circuit and tailings from the cyanidation circuit. Flotation tailings would make up approximately 90 percent of the total tailings produced. This material would contain no cyanide and low levels of sulfide. (Sulfides are potentially acid-generating minerals contained in the rock.) About half of these tailings would be filtered and trucked to the surface site for dry-stack storage. The other half would be used to make the paste backfill for the mine, along with the cyanidation tailings.

Tailings from the cyanidation circuit would make up only 10 percent of the total tailings flow. These “carbon-in-pulp” (CIP) tailings would contain approximately 90 percent of the sulfides released in the process. These tailings would be submitted to a cyanide destruction process, then mixed with roughly 50 percent of the flotation tailings and cement to make the paste backfill for mine support.

2.3.6 Tailings Disposal

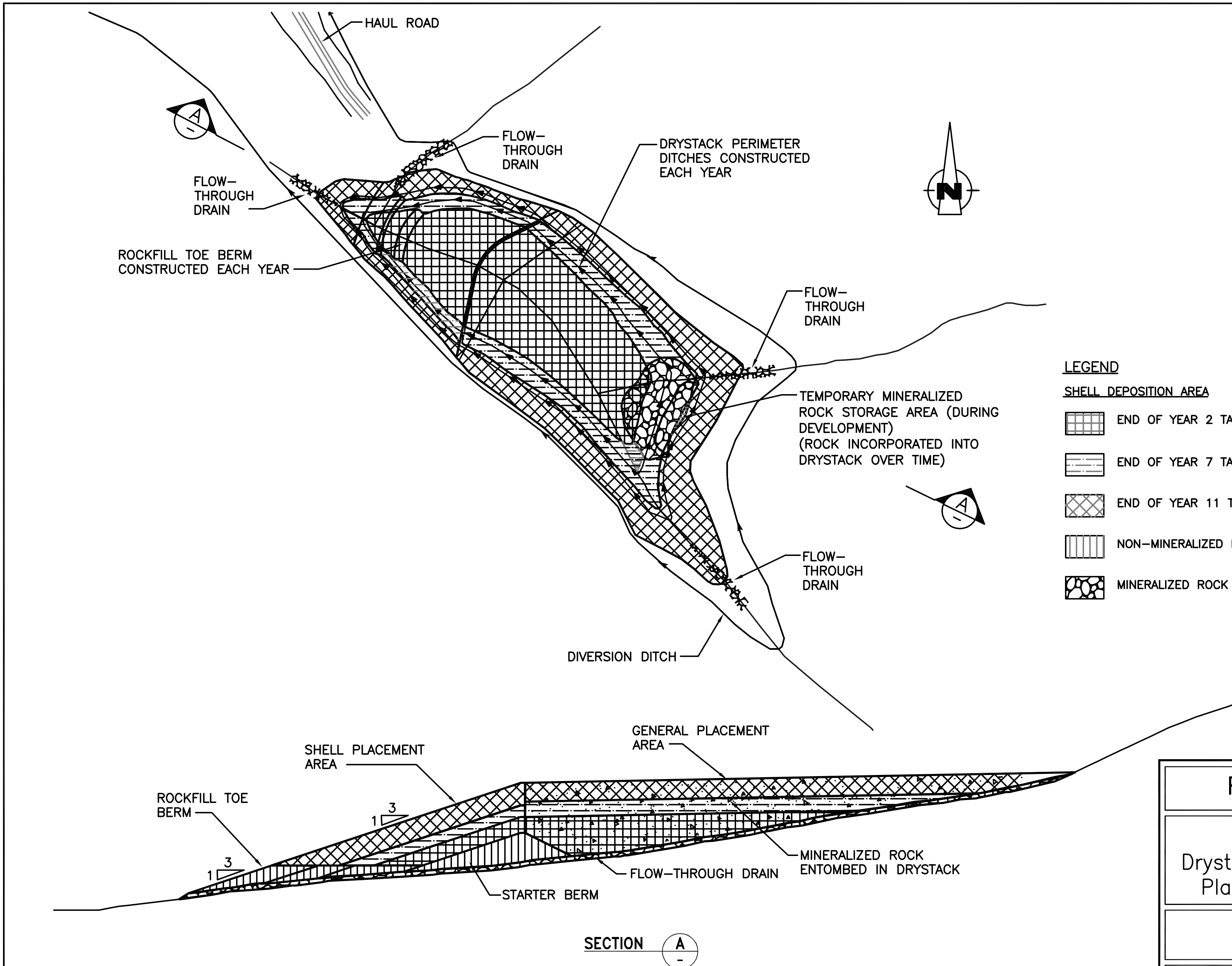
The Pogo mine would produce at least 11 million tons of tailings during its projected life. Approximately half of the tailings would be returned to the underground workings as cemented-paste backfill. The other half would be filtered to remove most of the water. The filtered material then would be delivered by truck to a dry-stack storage site at the head of Liese Creek, above the recycle tailings pond, where it would be spread and compacted as a solid earthen mass (Figure 2.3-1).

Paste Backfill

The CIP tailings from the cyanidation circuit would make up 10 percent of the total tailings flow, but would contain 90 percent of all sulfides originating in the ore. Following cyanide destruction, the CIP tailings would be mixed with flotation tailings and with approximately 2 percent cement in the paste backfill plant and pumped underground via pipeline. This combined material would harden into a relatively impermeable and stable mass when placed in the mined-out underground stopes. The hardened backfill would support the roof in mined-out areas and provide a working face and surface for mining equipment.

Dry-Stack Tailings Storage

The remaining half of the flotation tailings would be filtered to reduce the moisture content to between 12 and 15 percent, and then trucked to the dry-stack storage area on the surface of upper Liese Creek Valley (Figure 2.3-1 and 2.3-1 e). Figure 2.3-3 presents plan and section views of the dry-stack placement facility. The filtered tailings would be essentially inert, unsaturated silt and should form a seismically stable, non-acid generating and low permeability mass when placed and compacted in the stack. Development rock from the mine also would be placed within the dry stack. When the existing ore reserves were mined out, the dry-stack tailings facility is expected to contain approximately 5.4 million tons of tailings and approximately 1.9 million tons of development rock, for a total of 7.3 million tons. The site would have adequate capacity to hold a total of 20 million tons of material.



Pogo Mine EIS

Figure 2.3–3
Drystack Placement Facility
Plan and Section Views

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Both mineralized and nonmineralized development rock produced during mine operation would be blended with tailings material and entombed in the dry-stack storage pile. Encapsulating this rock within the solid tailings mass would minimize the oxidation of any sulfide minerals present, resist creation of seepage paths through the stack, and minimize the potential for leachate from the rock to enter the groundwater system.

The tailings would have a moisture content between 12 to 15 percent. However, because tailings have the potential to create dust, especially when they have been frozen or desiccated by the sun, procedures would be in place to control dust during drystack operations. The drystack area in the Liese Basin is not overly exposed to sun, and wind velocities are much lower than on adjacent ridges. Compacting the tailings would control dust substantially, as would controlling traffic on the drystack and limiting the use of equipment to active placement area(s) only. Summer rainfall should assist in keeping the surface moisture content within the acceptable range, although prolonged periods of warm weather with low humidity could make it necessary to build silt fences around non-active placement areas. In winter, silt fences might be required if the shell were exposed. During this time, natural or artificial snow coverings would provide cover for the shell area.

2.3.7 Laydown Areas

Construction laydown areas would be built on the Goodpaster Valley floor. Near the 1525 Portal, the existing 4-acre temporary nonmineralized development rock pile would be spread out to a total of 8 acres. Two smaller laydown areas would be developed near the existing gravel pit for a total of 4 additional acres. Another approximately 18-acre laydown area would be located adjacent to the new airstrip.

After construction, the laydown areas on the valley floor would be reduced in size, but still would be needed because of the steep nature of Liese Creek Valley, which would preclude a large laydown area at the mill.

2.3.8 Development Rock Storage

Approximately 1.92 million tons of development rock would be produced over the course of mine exploration, development, and operation (Teck-Pogo Inc., 2002i). This rock quantity includes approximately 126,000 tons already produced from the underground exploration program, and another approximately 410,000 tons to be excavated during the two-year mine development (pre-production) phase. An additional approximately 1.4 million tons of development rock would be produced from ongoing mining operations during the first 6 years of production. After 6 years, the flow of development rock would diminish because most of the underground facilities required for extraction of the ore deposit would be completed.

Development rock would result from various underground excavations, including ventilation raises, the ramp system, ore haulage system, ore passes, and ore access drifts. Development rock can be either mineralized or nonmineralized (more technically described as “weakly mineralized”). Development rock containing greater than 0.5 percent sulfur *or* 600 ppm arsenic is considered “mineralized” development rock, and rock with concentrations less than *both* of those values is considered “nonmineralized” development rock. To date, development rock produced by exploration activities has been segregated into stockpiles located on the valley floor below the existing 1525 Portal of the exploration adit (Figure 2.3-1 a).

During the mine development phase, development rock would be segregated as mineralized or nonmineralized; however, during the more time-critical operations phase, segregation on a round-by-round basis might no longer be feasible because of the bulk handling method to be employed. Thus, during operations, all development rock would be handled as mineralized rock unless otherwise analyzed and segregated on a round-by-round basis.

Nonmineralized development rock During the course of the entire project, approximately 411,000 tons of nonmineralized development rock would be placed underground, and approximately 840,000 tons of nonmineralized development rock would be placed on the surface. Test data shows that acid rock drainage and metals leaching should not be an issue for segregated nonmineralized rock stored on the surface. Nonmineralized development rock would be used as bulk fill on roads and pads, for construction of the RTP and toe berm of the dry stack, and as riprap. Up to 350,000 tons of nonmineralized rock not required for construction would be stored near the toe of the dry stack (Figure 2.3-1 e). Any rock not used to cover the dry stack after closure would be reclaimed in place.

Alternatively, if nonmineralized rock were not segregated on a round-by-round basis during operations, it would be handled as if it were mineralized, rock and therefore up to 493,000 tons of nonmineralized development rock could be placed in the dry stack.

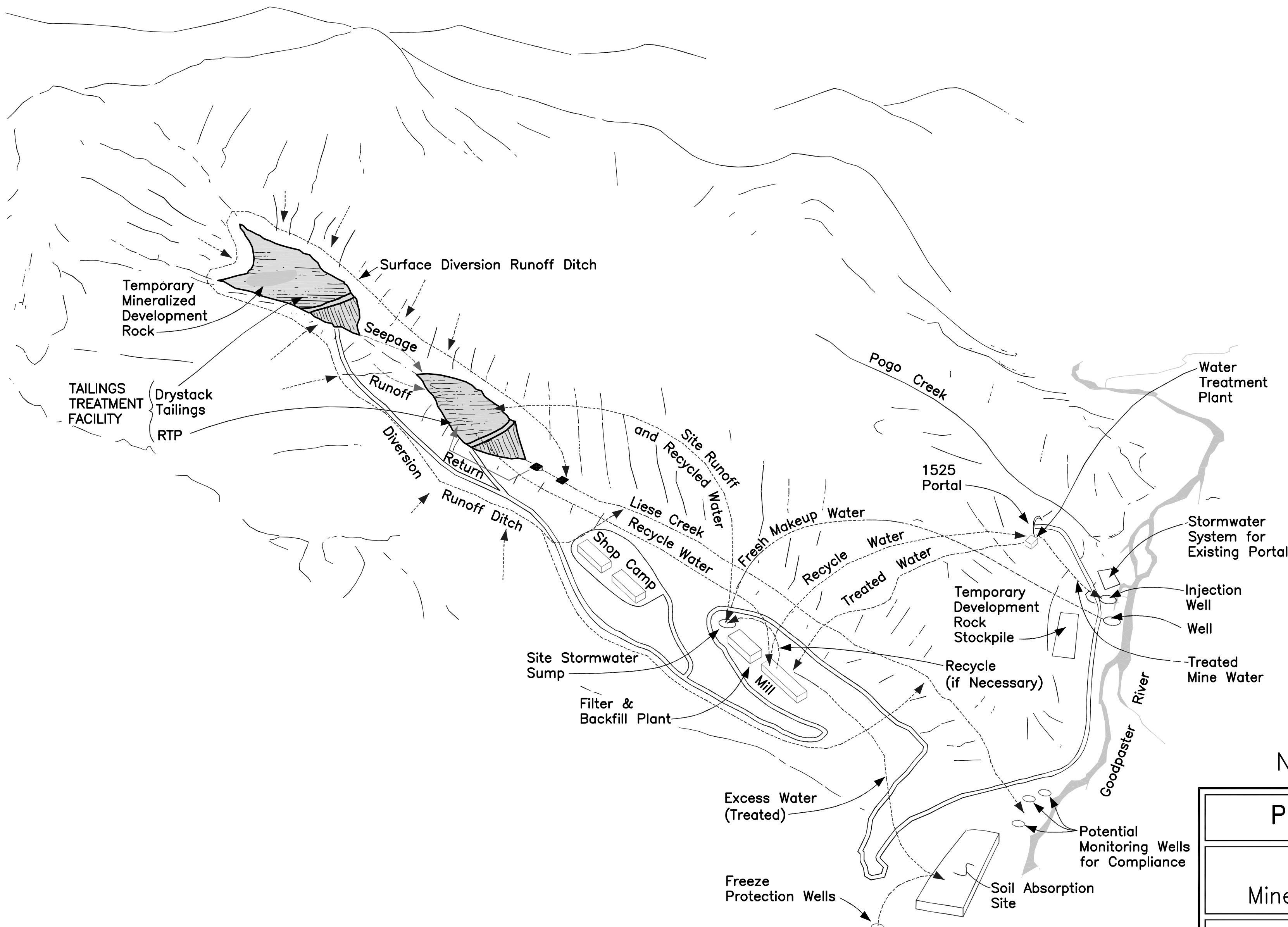
Mineralized development rock During the course of the entire project, approximately 436,000 tons of mineralized development rock would be placed underground, and 237,000 tons would be placed on the surface in the tailings dry stack. All mineralized rock ultimately brought to the surface would be disposed of in the tailings dry stack. During development, mineralized rock from the 1525 Portal would continue to be stored near the portal. Mineralized rock from the 1690 and 1875 portals would be hauled to a temporary stockpile within the overall footprint of the dry stack to minimize potential for oxidation and seepage. This rock, as well as the mineralized rock from the 1525 Portal temporary storage pile, ultimately would be encapsulated in the dry stack. Any development rock not brought to surface would be entombed underground in the backfill.

1525 Portal area storage The nonmineralized development rock that is presently stockpiled at the site below the existing 1525 Portal would be used as fill material in the laydown area and for road construction. This would free up the existing engineered polypropylene lined pad and allow placement of additional mineralized development rock on the existing lined pad as temporary storage. If there were more mineralized rock than could fit on the existing lined pad, the excess mineralized rock would be temporarily stored immediately to the north of the existing lined pad and would be moved to the temporary stockpile within the overall footprint of the dry stack in upper Liese Creek within 2 years. New nonmineralized development rock would be placed near the north end of the rock storage area over the existing vegetative mat.

2.3.9 Water Management

Geographical water flows in the mine area are shown in Figure 2.3-4. Figure 2.3-5 is a conceptual flow diagram for water management of the same mine area water flows.

The water management plan is based on maximum water recycle, minimal use of fresh water, and careful control of all site runoff. Recycled process water, mine drainage water, and surface runoff from the development area would meet mill process water requirements in most operating years. Fresh water would be needed for potable supply and would be used for processing when all other sources were inadequate. Fresh water would be obtained from groundwater wells.



Not to Scale

Pogo Mine EIS

Figure 2.3–4
Mine Area Water Flows

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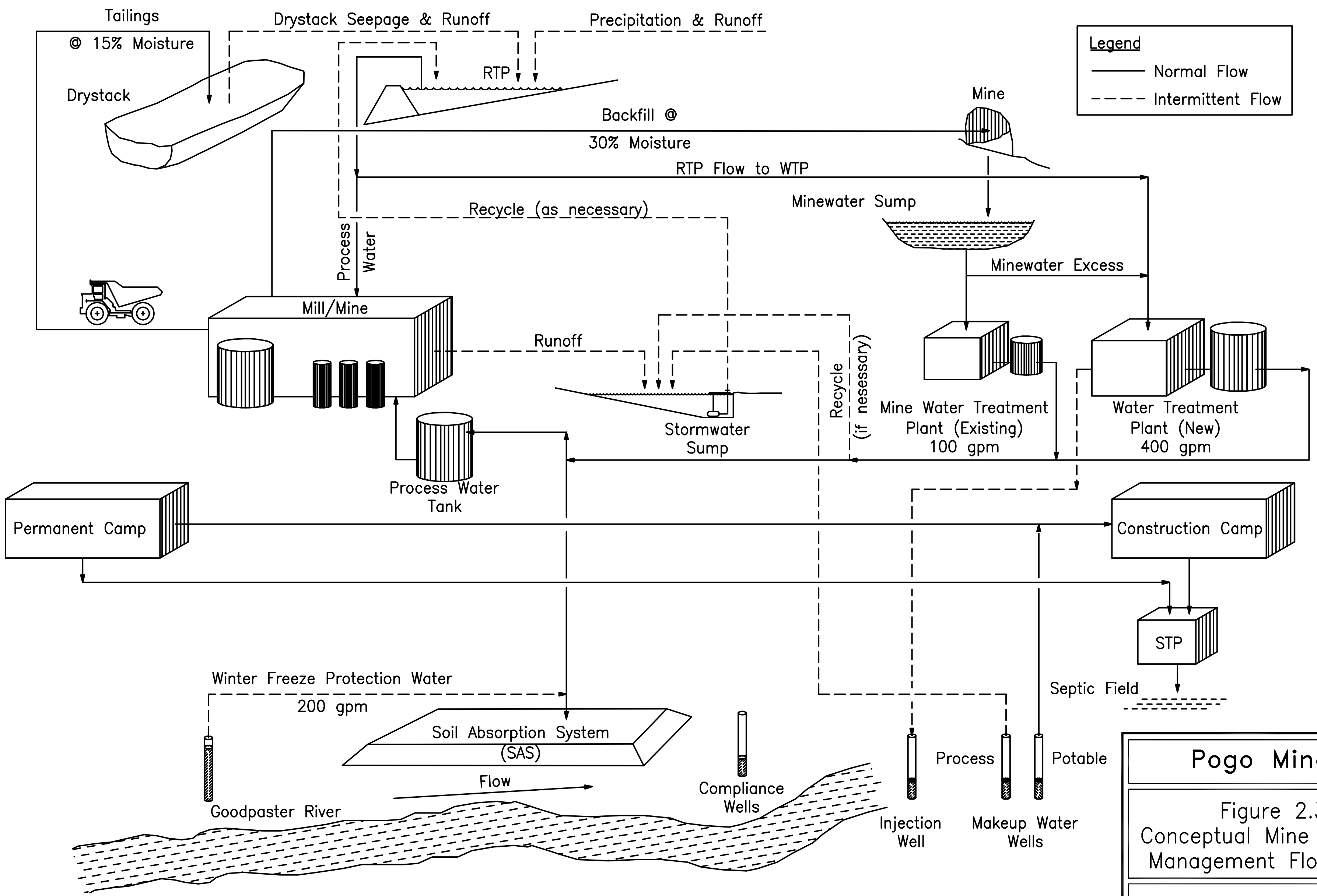

Pogo Mine EIS

Figure 2.3–5
Conceptual Mine Area Water Management Flow Diagram

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Surface Water and Runoff

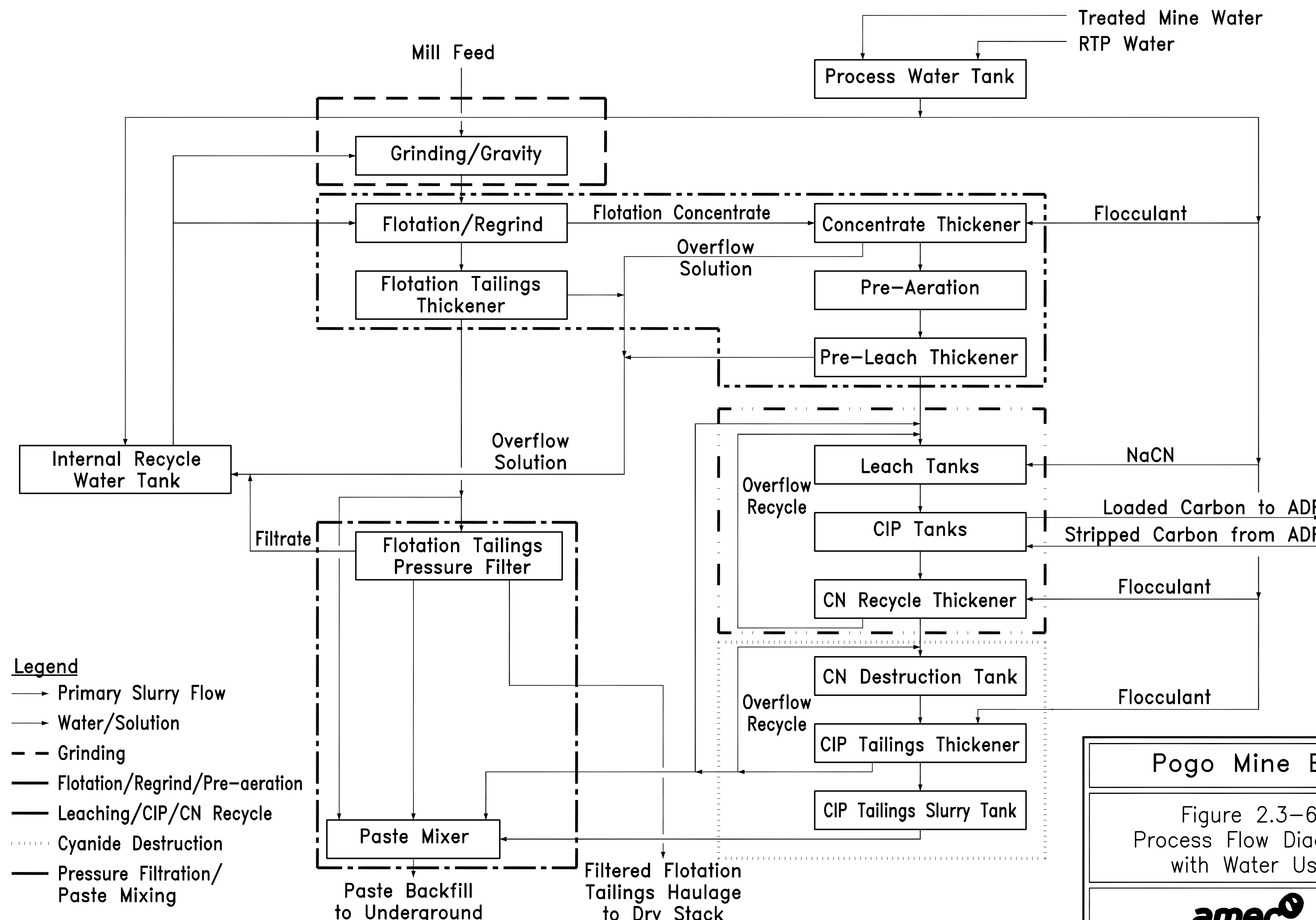
A central feature of the surface water control system would be a major diversion ditch on the hillside above and around the dry-stack tailings treatment facility and the RTP in upper Liese Creek Valley (Figure 2.3-4). The ditch also would run the length of Liese Creek uphill of, and parallel to, the dry-stack tailings and RTP access road on the north side of the valley. The diversion system would capture surface waters flowing into the Liese Creek drainage from above the site access road and would divert these waters around the dry-stack tailings facility. This would be "non-contact water," i.e., water that had not come into contact with project facilities or mineralized/chemically processed rock. It would be routed into material site A at the mouth of Liese Creek (Figure 2.3-1 b), which would be developed into a stormwater sedimentation pond after the development phase. Overflow from the pond would be directed through an outlet works back to Liese Creek without chemical treatment throughout the life of the mine and during decommissioning.

The diversion ditch would be a "detached" ditch, which is different from the roadside ditch adjacent to the dry-stack access road (Figures. 2.3-1 c, 2.3-1 d, and 2.3-1 e). The runoff from the roadside ditch along the access road to the dry-stack facility from the mill/backfill plant would be collected and directed to the stormwater sump near the mill site, where it subsequently would be pumped to the RTP.

Mill Process

The mill has been designed to operate with maximum recycle of water. A process flow diagram with water use is presented in Figure 2.5-6. Water would be recycled from the flotation and thickening circuits, stored in an internal recycle water tank, and pumped to the grinding and flotation circuits. The cyanide vat leach section of the process also would operate in closed circuit. All water affected by cyanide in this circuit would either be recycled to the head of the cyanide circuit in the mill for reuse, or remain in the filtered CIP tailings after cyanide destruction. Therefore, all water that would be exposed to cyanide in the mill and leave the cyanide circuit would be contained in the cemented-paste backfill for the mine. The only water released from the process would be to the tailings themselves as either part of the cemented-paste backfill (cyanide and flotation tailings), or as residual moisture in the surface dry stack (flotation tailings only).

An estimated 1,174 gallons per minute (gpm) of water at 2,500 tpd, and 1,622 gpm at 3,500 tpd, would be required for processing, primarily for slurry preparation with the ground ore, for mixing reagents, and for flotation. Approximately 107 gpm of makeup water at 2,500 tpd (149 gpm at 3,500 tpd) would be needed to replace water retained in the tailings material. Water would be obtained from three sources (listed in order of priority) to satisfy the makeup requirement. mine drainage water, RTP water, and fresh water from wells. Mine drainage water likely would satisfy all the process water requirements under most circumstances for the project. A conceptual site water balance for an average case at 2,500 tpd is shown in Figure 2.3-7.



Pogo Mine EIS

Figure 2.3-6
Process Flow Diagram
with Water Use

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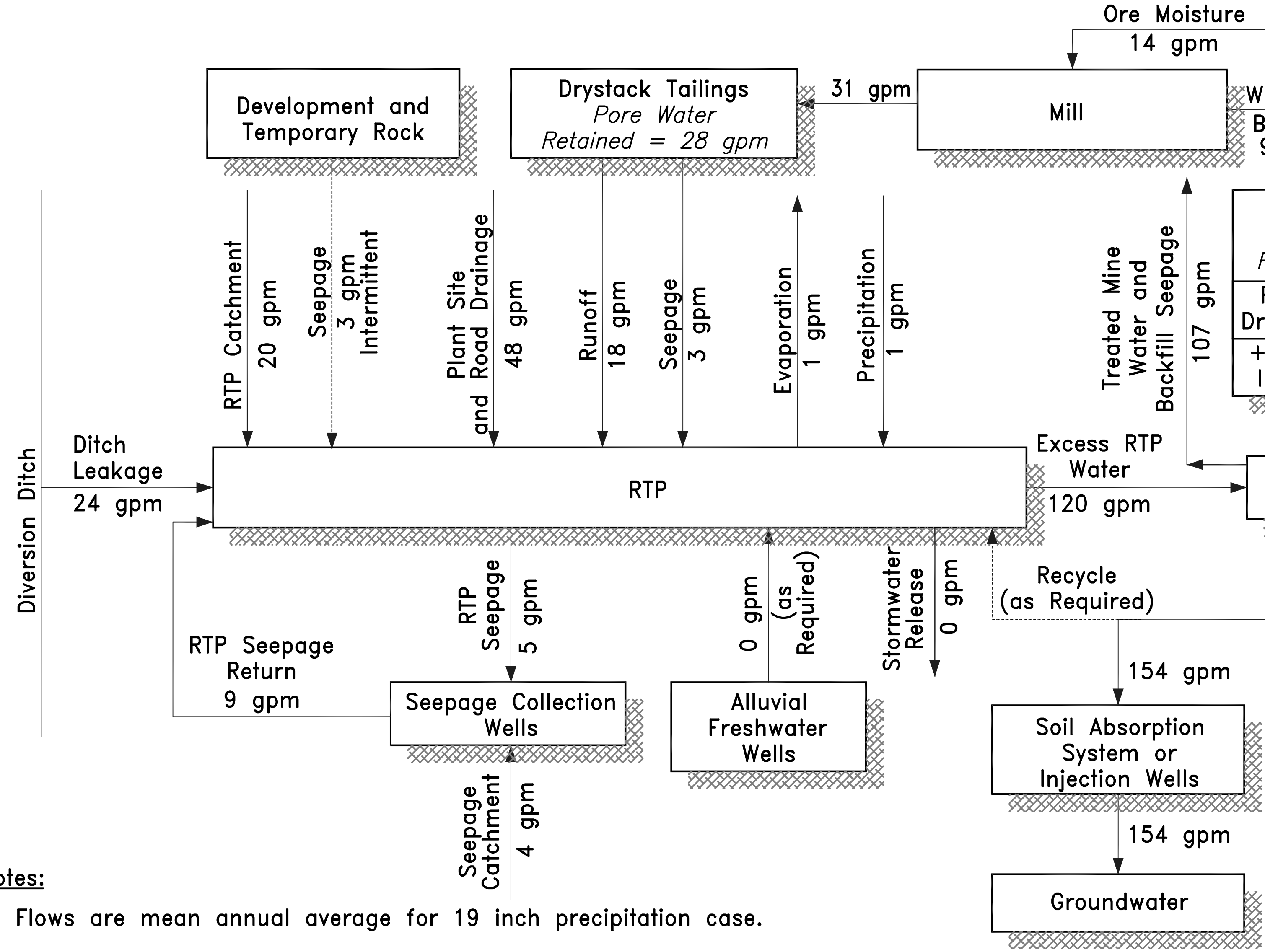
18 July 2002 | AMEC File:PDEIS Figure 2.3-6



Notes:

1. Flows are mean annual average for 19 inch precipitation case.
2. Average mine inflow.
3. All development rock is incorporated in the drystack by year 6.
4. Up to 200 gpm of freeze–protection water would be pumped from the alluvial freshwater wells to the SAS.

Pogo Mine EIS

Figure 2.3–7
Conceptual Site Water Balance at 2,500 tpd – Average Case

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Mine Water

Mine water inflows are expected to average approximately 139 gpm, with a peak annual inflow of approximately 205 gpm. The mine drainage water is expected to have low but measurable levels of cyanide and other metals. All available mine water would be used in the mill process before any additional makeup water were obtained from the RTP to ensure that the residual cyanide and metals in the mine water would be entrained in the tailings solids sent either to the underground as cemented backfill or to the dry stack. Mine water likely would satisfy all the process water requirements under most circumstances for the project. Mine drainage water would be collected in a large sump in the mine and pumped to treatment facilities either in the mine or near the mouth of the existing 1525 Portal in the Goodpaster Valley, from which it would be discharged to the injection wells or soil absorption system (SAS), sent to the mill as process water, or recycled to the RTP.

Recycle Tailings Pond

Water would accumulate in the RTP from snowmelt, stormwater runoff from the mill, camp and associated roads, seepage from the dry-stack tailings, and fresh water pumped to the RTP to provide water during dry periods when precipitation and mine water inflows were insufficient for process plant needs. RTP water would be used for process makeup requirements to fill demand not met by mine water flow.

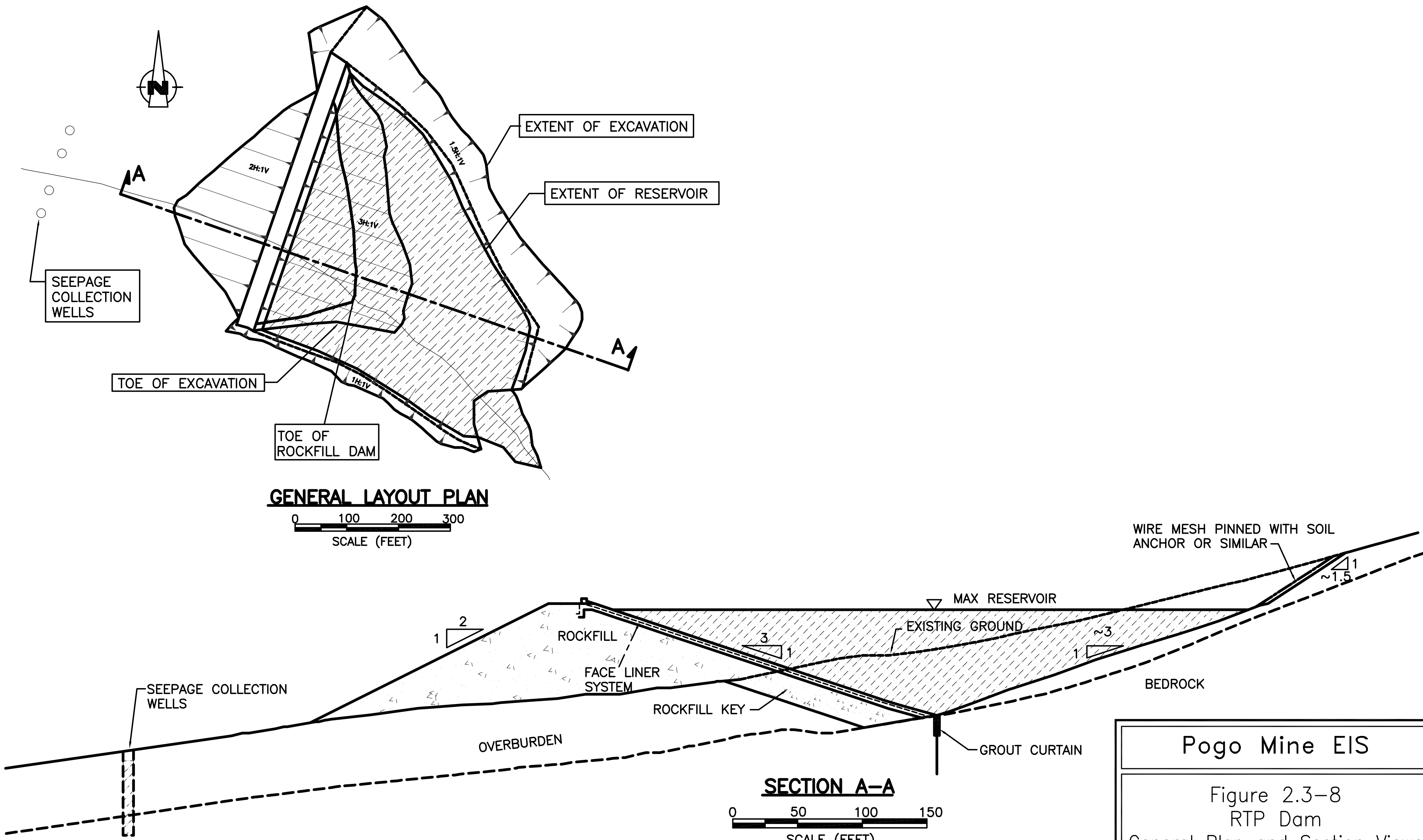
The RTP would be built by constructing a dam downstream of the dry-stack tailings facility in Liese Creek Valley. A cross-section view of the 40-million-gallon RTP is shown in Figure 2.3-8. Although the bottom of the RTP would be unlined, the dam itself would be a lined, rock-fill structure with expansion capability. The RTP would provide storage for snowmelt runoff and the 100-year, 24-hour-intensity storm event. Summer season operating water levels in the dam would be kept below the 100-year, 24-hour-storm volume requirement. The RTP would provide a total of 40 million gallons of water storage. Modeling showed the RTP would overtop and discharge without treatment only infrequently (22 times in 1,000 years) during major storm or runoff events.

The dam would be constructed with nonmineralized development rock and local borrow materials from within the water storage basin. Because of the absence of adequate fine-grained soils in the vicinity for developing a dam core of high integrity, a composite synthetic liner system would be placed on the upstream face of the dam. This liner system would be tied into a vertical seepage cutoff trench and/or extended in a sloping trench at the upstream toe. Selection of the actual method of seepage cutoff would depend on the preferred technical alternative.

A seepage collection well and pump-back system would be incorporated into the downstream toe of the dam. The seepage wells would be installed through all overburden and into the bedrock beyond the immediate downstream toe of the 40-million-gallon dam. This system would allow for dam raising downstream, providing an appropriate degree of flexibility at this stage of design. A system of monitoring wells would be developed downstream of the seepage collection wells to monitor the performance of the seepage collection system.

Fresh Makeup Water

Fresh water would be added to the RTP for makeup water when the other water sources were inadequate for process requirements. This water would come from wells in a suitable area of alluvial sediments in the Goodpaster Valley and in upper Liese Creek Valley above the dry



Pogo Mine EIS

Figure 2.3–8
RTP Dam
General Plan and Section Views

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stack, to supply at least 150 gpm of fresh water. A fresh water supply pipeline would be routed from the wells to the RTP and to the plant site for potable water supply.

Potable Water

There would be three potable water supply sources. The first would be wells drilled into the alluvial gravels of the Goodpaster Valley near the 1525 Portal to supply the construction camp (Figure 2.3-1 a). The second would be wells drilled into the colluvium in upper Liese Creek Valley above the dry stack (Figure 2.3-1 e). These wells would have two purposes: water supply and dewatering of the colluvium to reduce winter water flows in the diversion ditches.

The third possible source would be the wells drilled in the Goodpaster Valley upstream of the off-river treatment works (Figure 2.3-1 b). If the upper Liese Creek wells were inadequate, the wells in the Goodpaster Valley, either near the 1525 Portal or near the off-river treatment works, would be used.

A treatment facility would filter and chlorinate the potable water before use. An average of approximately 100 gallons per day (gpd) of potable water would be required for each camp resident.

2.3.10 Water Discharge

Treatment

All water from the RTP and the mine drainage would be treated at one of two treatment plants before discharge. The existing 100-gpm plant would remain underground, and the new 400-gpm plant would be built on the surface near the existing 1525 Portal. Both plants would be capable of discharging to both the SAS and the underground injection wells, and could provide process water to the mill and recycle water to the RTP.

The water treatment plants would use two processes to remove contaminants from the water before discharge. A high-density sludge process would enhance co-precipitation of metals, including arsenic. A lime-softening and recarbonation process would remove calcium and magnesium and thereby reduce total dissolved solids (TDS). Sulfide precipitation, which would precipitate heavy metals such as lead, cadmium, and copper to the sludge, would be available as a contingent measure if additional treatment were necessary.

The final treatment stage would use a multi-media pressure filter to polish the treated water for removal of residual suspended solids prior to discharge to the SAS. Excess sludge generated by the process would be dewatered by using a filter press to produce a cake for underground disposal with tailings paste backfill.

The flexibility would exist to discharge directly to the injection wells on an as-needed basis if the treated water were of sufficient quality to meet the injection well influent criteria.

Soil Absorption System

The SAS would consist of a distribution pipe network placed above an approximately 4.4-acre engineered soil column adjacent to the airstrip (Figure 2.3-1 b). The system would deliver water at up to 400 gpm from the water treatment plant. Water would flow down through the absorption system and into the near-surface alluvium material of the Goodpaster floodplain. Figure 2.3-9 shows a cross section and details of the SAS.

The absorption field would use perforated pipe and a mixed soil consisting of medium sands and silts with some organic component. During passage through the soil, residual metals would be removed through adsorption onto the soil particles. Cyanide metal complexes would be removed through adsorption and biological degradation. Ammonia would be removed by biological degradation in a manner analogous to a septic leach field. Diffusion and travel time would result in the attenuation and dispersion of the treated water. Modeling showed approximately 1 year of travel time between the SAS and the Goodpaster River (AMEC, 2001b; Teck-Pogo Inc., 2002f, Appendix C). [Uncertainty in these predictions may be considered moderate, given the reasonably good knowledge of the alluvial groundwater flow system hydraulics. The choice of conservative input values tended to skew model inaccuracies toward the conservative side, thus providing a model that yielded results that may reflect a conservative estimate.]

Industrial Wastewater

Precipitation and other water reaching the RTP in excess of the project's water recycle needs would be treated near the existing 1525 Portal as necessary and discharged via the SAS. Discharge would not exceed the net allowable discharge, defined as the net precipitation in excess of evaporation plus mine drainage. Excess precipitation and other water that would collect in the RTP under normal operating conditions is expected to have relatively low contaminant levels. Still, treatment to achieve water quality standards before discharge would be necessary. As the mill process is designed, minimal cyanide should reach the RTP; however, the soil absorption system would be capable of treating cyanide (Teck-Pogo Inc., 2002b).

Domestic Wastewater

For the initial development phase, a package treatment plant at the construction camp below the 1525 Portal would discharge to an underground drain field at the camp. Once the mill and camp complex was constructed, lift stations would be located in each of the main buildings to pump sanitary sewage to a package treatment plant within the camp complex. During the remainder of the development phase, treated effluent from this plant would be discharged to a temporary underground drain field on the south-facing side slope below the camp in Liese Creek Valley. During operations, treated effluent would be piped through the mine to the permanent underground discharge field at the construction camp. Sludge from the package treatment plant would be periodically removed and disposed of in accordance with ADEC-approved procedures.

2.3.11 Power Supply

The maximum power demand for the mine, mill, camp complex, and other facilities is estimated to be 10 MW at 2,500 tpd throughput and 14 MW at 3,500 tpd. To meet this demand, the Applicant would construct a 138-kilovolt (kV), three-phase power line, from the Golden Valley Electric Association (GVEA) Fairbanks to Delta Junction power line near the Richardson Highway to the mine site (Figure 2.3-2). The power line would originate from a new, approximately half-acre substation at the existing transmission line near TAPS north of Shaw Creek Road (Figure 2.4-4).

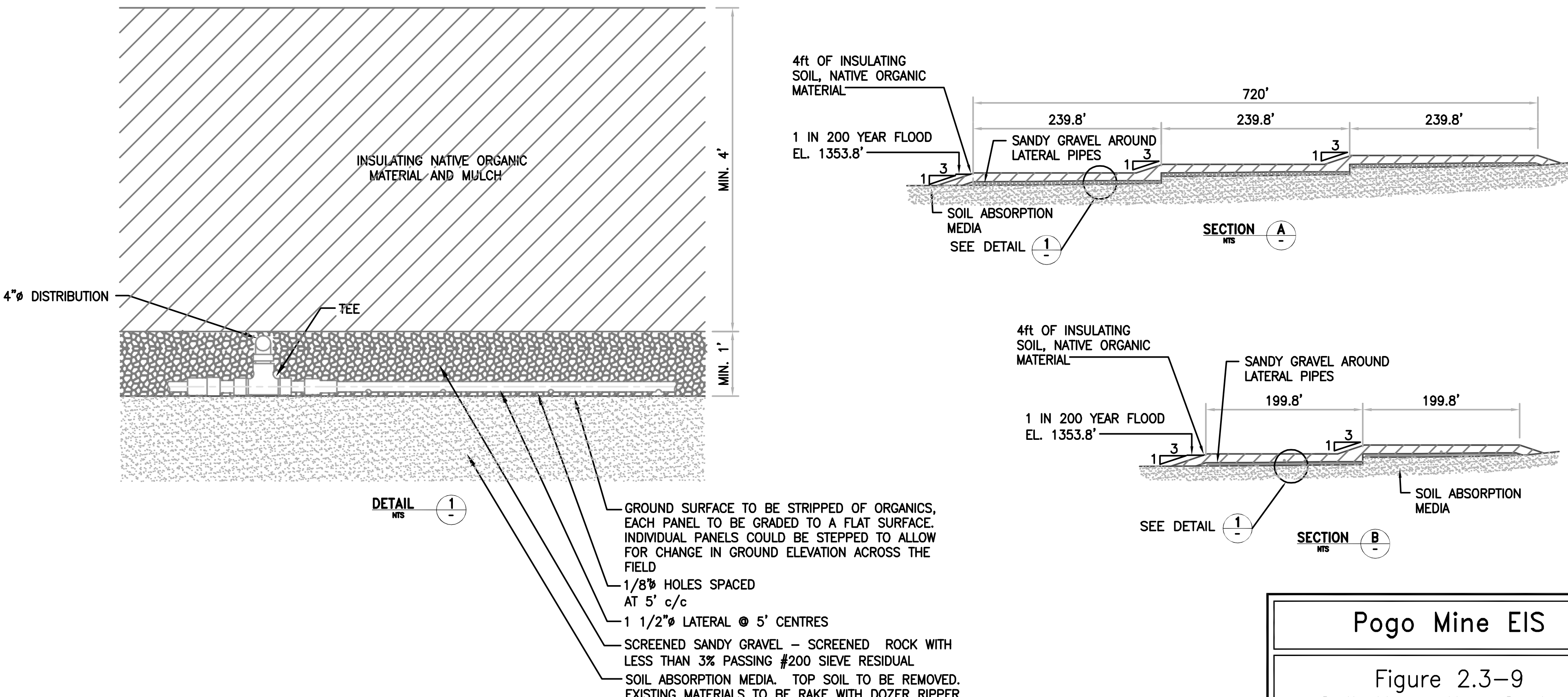

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Figure 2.3-9
Soil Absorption System
Sections and Details

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The power line generally would closely follow the Shaw Creek Hillside all-season road, with approximately 40 percent of its route being a single, combined corridor cleared for both components. The route would be up Shaw Creek Valley and over the Shaw Creek and Goodpaster River divide to the mine site. The power line would deviate in a major way from the road in two places, however. The first would be in the vicinity of Caribou Creek. The second would extend an additional two miles up Shaw Creek Valley and then turn east up Sutton Creek Valley. This would avoid exposure to wind and icing which likely would occur along the all-season road route following the ridge crest.

The “H-frame” power pole configuration would consist of two tapered wood poles, a wooden cross arm, and a wooden cross brace if needed for strength purposes, similar to the existing GVEA transmission line between Fairbanks and Delta Junction. Structures would be anchored using stranded steel guy wire and soil or rock anchors. Typical structures would be approximately 70-ft tall. Spans would range from 400 ft to 1,200 ft, with most spans ranging from 600 ft to 800 ft. All wood members would be pressure treated to reduce decay. A 30-ft minimum vertical clearance for the wires above ground would be maintained where the line crossed roads and areas likely to be accessed by snow machines; a 26-ft minimum vertical clearance for wires would be maintained elsewhere. At the Goodpaster River Bridge, the line would be suspended directly from towers on both sides of the river, independent of the bridge. No power line structures would be placed in the Goodpaster River bed.

Where the power line followed the road across wetlands, power poles would be placed as close to the road as possible to minimize disturbance of wetlands. Where the power line was not adjacent to the road, some clearing and spur trail development from the road would be necessary for equipment access for pole installation and stringing line. At these spur trails, fill would be placed as needed to create ramps extending 20 ft to 40 ft beyond the toe of the road embankment. Spur trails would be sited to minimize disturbance to wetlands. Most wetland access would occur with low-ground-pressure vehicles. The portion of the power line between upper Shaw Creek Valley and the Shaw Creek and Goodpaster River divide above Wolverine Creek would be accessed by helicopter or in winter over a winter road constructed along the power line alignment.

Poles typically would be embedded by auguring an approximately 30-in.-diameter, 10-ft-deep hole, and then back filling. In areas with poor soil conditions such as wetlands, driven pipe pile foundations (approximately 30 in. diameter) and anchors (approximately 8 in. diameter) could be needed to support the structures. These sites would be accessed by low-ground-pressure vehicles in winter or by helicopter.

The approximately 43-mile power line ROW would be 125 ft wide. Vegetation would be cleared near ground level by hand, hydro-ax, or other mechanical means. The vegetative mat would be left intact where feasible. There would be no blading of ground vegetation in flat-lying wetland areas. Vegetation more than 10 ft tall generally would be cleared, but it could be left intact in such areas as depressions, gullies, swales, or over low-vegetation wetlands were it was determined to be sufficiently below the power line conductors. At a minimum, any tree with the potential to fall and contact the wire or pole structures would be removed, even outside the ROW. The ROW width would be periodically cleared with the intent of protecting the line from forest fires.

Step-down transformers (138 kV/4.16 kV) would be installed at the mine site. Site distribution voltage would be 4,160 volts. On-site backup power would be supplied by two 750-kilowatt (kW) generators at the mill, two 500 kW generators at the camp, and a 250-kW generator at the water treatment plant. This backup power capacity would be sufficient to power key motors, pumps, water treatment, and lighting both underground and on the surface. These items would draw from the same fuel storage facilities as would the mobile equipment.

2.3.12 Fuel Supply

During construction, the existing facility for diesel fuel storage at the exploration camp near the 1525 Portal, consisting of eight 20,000-gallon tanks, would continue to be used on a temporary basis. An additional fifteen 20,000-gallon diesel tanks would be placed temporarily on the apron at the new airstrip. These tanks would be filled during operation of the winter road; they would continue to be supplied by air as necessary until the all-season road was completed. All tanks would be located within a bermed and lined containment area with a capacity of at least 110 percent of the largest tank. Once construction was completed, all diesel storage tanks at the construction camp and the new airstrip would be removed from the valley floor.

During operations, main permanent diesel storage would consist of two 20,000-gallon tanks located near the maintenance shop in Liese Creek Valley, with a 5,000-gallon tank at the mouth of the 1525 Portal 200 ft above and 1,400 ft from the Goodpaster River. A fuel truck would transfer fuel from the main storage tanks for delivery to remote equipment and smaller storage tanks.

Smaller diesel tanks with secondary containment would be located at the mill building and the camp. These tanks would be used for fuelling heaters, backup generators, and the incinerator. The total on-site capacity for diesel fuel storage during operations would be approximately 50,000 gallons.

A 5,000-gallon tank would be located permanently near the new airstrip for storing Jet-A fuel.

Up to 50,000 gallons of propane storage would be provided near each of the 1525 Portal and the 1875 Portal. These tanks would supply the mine air heaters and would typically be full only in the winter months. An additional 5,000 gallons of propane storage would be placed near the mill to fire the carbon-stripping water heater. A total of approximately 105,000 gallons of propane storage would be provided on site.

Diesel and propane would be transported to the site over the initial Goodpaster Winter Trail in 5,000-gallon tanker trucks. The tanks then would be refilled as necessary by 8,000-gallon tanker trucks using the all-season road for the life of the project.

Near the maintenance shop in Liese Creek, up to 5,000 gallons of used oil would be stored. This oil would be dewatered, filtered, and burned for shop heat. Records would be kept to document whether the oil was on or off specification.

2.3.13 Material Sites

Approximately 1.1 million cu yd of gravel and rock materials would be excavated, and approximately 955,000 cu yd would be placed to construct the mine site facilities. Cuts and fills would be balanced throughout the project wherever possible.

Three material sites would be developed in the Liese Creek Valley to support project development. Material site A, located near the mouth of Liese Creek (Figure 2.3-1 b), would be required for initial construction and would be used to provide fill for the road in Liese Creek Valley.

Material site B would be developed to produce coarse rock for construction of the rock-fill RTP dam (Figure 2.3-1 e) This site also would be used for riprap and other rock-fill requirements as needed. After initial construction, portions of this site would be used as a surface solid waste facility for disposal of general wastes.

Material site C, adjacent to site B, would be developed to produce riprap and other bulk fill needed for project closure, including the riprap required to armor the dry-stack perimeter channels.

Approximately 140,000 cu yd of gravel would be required from borrow pits in the Goodpaster Valley alluvial gravels. Approximately 870,000 cu yd of rock would be excavated. Rock material sources would be developed in conjunction with construction of the major facilities for the project (i.e., at the 1525 Portal, mill site, campsite, and RTP area).

Gravel mining would be conducted according to the following design criteria:

- Larger timber, more than 8 in. in diameter, on the borrow sites would be sawed and used for construction or support activities or would be cut, decked, and removed for sale off site or otherwise disposed of pursuant to DOF regulations.
- Smaller timber, slash, and brush would either be chipped or mulched and would be added to the topsoil as an amendment.
- Organic material consisting of surface vegetation, stumps, and root wads would be segregated and stockpiled. Silt and sand overburden would be segregated and would be stockpiled and maintained in a manner to minimize wind and water erosion and compaction until required for reclamation purposes.
- Excavation would be limited to within 10 ft of the outer perimeter of the cleared area.
- In thawed areas, gravel mining would be conducted by dragline to increase digging depths and reduce the surface disturbance required. In frozen areas, gravel mining would be conducted by drilling and blasting. Expected pit depths would be approximately 25 ft, with side slopes of 1.5 to 1.
- Shoreline length and diversity would be maximized to the extent practicable. Consideration would be given to maintain appropriate pit slopes to ensure stability and avoid wildlife entrapment.
- The gravel pit locations would provide appropriate setback distances from the Goodpaster River.

2.3.14 Organic and Growth Media Management

Organic material such as surface vegetation, root wads, and growth media from certain areas of the project, would be segregated and stockpiled for future use. Growth media is the near-surface soil, silt, and sand that could be respread in the future to support revegetation.

An estimated 185,000 cu yd of growth media would be salvaged, stockpiled, and protected from erosion due to wind and water through Best Management Practices (BMPs). The stockpiles also would be seeded which, in addition to helping prevent erosion, would enhance the growth media's biological properties that aid in nutrient absorption.

What is a BMP?

A Best Management Practice (BMP) is a way of doing something to meet an objective, often to minimize a particular impact. As an example, in the context of preventing soil erosion from construction-related ground surface disturbance activities, BMPs could include:

Spruce bough barrier – spruce tree sections, including fully needled boughs and limbs salvaged from clearing operations, may be placed in road ditches or at the toe of slopes to reduce flow velocity and encourage sediment dropout.

Natural vegetative filter – natural vegetation will be left in as close proximity to the construction disturbance as possible in order to trap silt or sediments before they reach a watercourse.

Check dams – a small device constructed of rock, sandbags, or fiber rolls, placed across a natural or man-made channel or drainage ditch. Check dams reduce scour and channel erosion by reducing flow velocity and encouraging sediment dropout

Desilting basin – a temporary basin formed by excavation and/or construction of an embankment so that sediment-laden runoff is temporarily detained under quiet conditions, allowing sediment to settle out before the runoff is discharged.

Straw bale barrier – a temporary linear barrier consisting of straw bales, designed to intercept and slow sediment-laden sheet flow runoff to allow sediment to settle before water leaves the construction site.

2.3.15 Refuse Disposal

All on-site refuse would be disposed of as authorized under the mill site permit. After initial construction, portions of material site B adjacent to the surface dry stack in upper Liese Creek Valley would be used as a surface solid waste facility for disposal of general wastes (Figure 2.3-1 e). The facility would be developed as a series of cells that would be kept to a manageable size to allow progressive reclamation. Cells would be covered with a layer of soil or nonmineralized development rock to minimize water percolation and ensure that buried refuse would not attract wildlife such as bears. The surface surrounding the facility would be graded to prevent precipitation from ponding or draining into it, and surface water runoff would be collected and routed to the RTP. Two monitoring wells would be placed in the bedrock downgradient of the surface facility.

This solid waste facility would receive nonhazardous waste products such as dewatered sewage sludge, incinerator ash and residue, iron (e.g., drill steel, balls, and empty cans), tires, empty plastic and glass containers, empty triple-rinsed chemical containers, contaminated soils, spill boom, liners used for the containment of spilled materials, chemicals used in the cleanup of spills or other spill cleanup wastes, and construction debris.

Clean general mine refuse (such as pallets, cardboard packaging, nonrecyclable containers, and nonputrescible refuse) either would be first burned in diesel-fired incinerators or burned in open pits and then placed in the facility. Putrescible wastes would be stored indoors, or would be stored outdoors in closed containers in a fenced area to prevent access by wildlife. All putrescible refuse would be incinerated before being buried in permitted, on-site trenches. The incinerator would operate under a permit from the ADEC and would comply with all state air-quality regulations.

Materials not designated for disposal on the site would be sorted and shipped to Delta Junction or Fairbanks for recycling or disposal. All waste material either listed as, or meeting the characteristics of, hazardous waste would be shipped off the site and disposed of according to applicable state and federal regulations. All used oil filters would be drained and disposed of in an approved manner or recycled for scrap metal. Waste petroleum oils would be stored on the site for reuse as fuel for space heaters or would be transported off the site for recycling.

2.3.16 Commodities Transport

Delivery of major commodities to the mine site would be as follows:

- Cement would be transported in 27-ton capacity bulk trucks.
- Grinding balls would be transported on trailers.
- Process consumables and spare parts would be transported primarily in containers.
- Food would be transported in containers.
- Highway truck-trailers would carry two containers per trip and would be limited to a payload of 10.5 tons of cargo per container, totaling 21 tons of cargo.

Table 2.3.2 and Table 2.3-3 show the materials quantities that would be transported to the site during construction and operation, respectively.

Table 2.3-2 Commodities Transport Quantities During Construction (tons)

Commodity	Year 1	Year 2	Total Freight
Mining equipment	2,000	5,000	7,000
Mining consumables	2,000	3,000	5,000
Concrete materials	1,100	-	1,100
Structural steel	1,400	-	1,400
Architectural	-	2,400	2,400
Mechanical equipment	-	3,400	3,400
Instruments	-	300	300
Construction equipment	900	-	900
Temporary facilities	400	-	400
Fuel	5,000	4,000	9,000
Food & camp supplies	400	400	800
Miscellaneous	2,850	2,850	5,700
Total	**14,050**	**21,350**	**37,400**

Source: Teck-Pogo Inc. (2002a)

Table 2.3-3 Annual Commodities Transport Quantities During Operations (tons)

	Commodity		2,500 tpd Scenario	3,500 tpd Scenario
Mine	Cement		14,000	21,000
	Propane		2,000	4,000
	Consumables		4,000	6,000
	Explosives		1,000	1,500
		Subtotal	21,000	32,500
Mill	Grinding Media & Liners		2,000	3,000
Mill Reagents	Lime		1,000	1,500
	Sodium cyanide		1,000	1,500
	Potassium amyl xanthate		41	57
	Aero Promoter 208		68	96
	MIBC		64	89
	Flocculant		55	77
	Sulfuric acid		500	750
	Sodium metabisulfite		1,000	1,500
	Copper sulfate		50	75
	Activated carbon		5	10
	Nitric acid		20	30
	Sodium hydroxide		30	45
		Subtotal	3,833	5,729
Fuel	Gallons		786,000	1,300,000
	Tons		2,800	4,620
Spare Parts			250	400
Food & Camp Supplies			290	500
		Total (tons)	30,173	46,749
Personnel			10,000	14,700
Bus Round Trips			330	490

Source: Teck-Pogo Inc. (2002i)

2.3.17 Reagent Handling

Reagents typically would be purchased in normal commercial bulk containers or packaging, such as tote bins, barrels, palletized sacks, and Super Sacks, and would be loaded into shipping containers at the point of origin and shipped to the mine site. Cyanide would be transported only as dry pellets inside plastic bags inside wooden boxes inside metal shipping containers in conformance with all federal and state hazardous materials transportation regulations. Reagents would be stored in a covered building adjacent to the mill. All storage areas would be diked for collection of spillage and cleanup to prevent loss to the environment. Reagents would be mixed in steel or other tanks inside the mill building and be pumped to their addition points in the process. Any spills would be contained within the concrete dikes of the reagent area and collected in a sump for disposal or for return to the process tanks.

A spill response plan for shipment of hazardous materials, including cyanide, would be required as an ADEC permit condition.

2.3.18 Explosives Handling and Controlled Firing Area

Explosives would be transported to site by means of conventional truck haulage, and would be used on site, in accordance with U.S. Bureau of Alcohol, Tobacco, and Firearms regulations.

Explosives would be stored underground in an explosives magazine. Locked storage magazines would be provided for caps, detonating cord, primers, and boosters. Secure storage would be provided for blasting agents such as emulsion, and bagged ammonium nitrate or ammonium nitrate/fuel oil. Any spills would be collected in a containment area and disposed of in accordance with applicable federal and state standards and regulations.

A controlled firing area (CFA) would be established in which explosive activities would be conducted in a controlled manner to prevent any hazard or impact on aircraft. Within the CFA, the Applicant would keep watch for passing aircraft and immediately terminate the hazardous activity if an aircraft approached the area. Also, certain visibility conditions would be adhered to. There would be two controlled firing areas, one with horizontal boundaries which would approximate the millsite lease boundaries, the other which would approximate the road construction corridor, with a vertical distance between ground level and 500 feet above ground level. Blasting activities within the CFA could potentially occur 24 hours per day throughout the project life.

2.3.19 Spill Containment

The plant site would be designed with levels of containment for spills. Any reagent spills would be contained within the concrete dikes of the reagent area and collected in a sump for disposal or for return to the process tanks. Any spills of cyanide leach solutions or other process materials would be contained within concrete diked areas within the mill building or around outside process tanks. In the unlikely event that a spill were to escape the building, all surface drainage would flow to sumps on the plant site. Such collected internal or external spills would be returned to the mill process.

2.3.20 Mine Equipment

Table 2.3-4 contains a preliminary list of mine site equipment.

Table 2.3-4 Preliminary Mine Large Equipment List

Equipment Item	No.	Equipment Item	No.
Two-boom electric hydraulic jumbo	4	Explosive loading vehicles	2
One-boom electric hydraulic jumbo	1	Mechanic's vehicle	1
Rock bolters	2	Fuel truck	1
Load haul dump truck – 8 cu yd	4	Lube vehicle	1
Load haul dump truck – 6 cu yd	2	Personnel carrier	5
Load haul dump truck – 3 cu yd	1	Electrician's vehicle	1
Load haul dump truck – utility with forks	1	Water pumping truck	1
50-ton diesel haulage trucks	4	Service scissors lift	2
Dozer	1	Grader	1

Source: Teck-Pogo Inc. (2002a)

2.3.21 Worker Accommodations

Workers would be housed in a permanent camp uphill of the mill site in Liese Creek Valley (Figure 2.3-1 and 2.3-1 d In addition to sleeping quarters, the camp would include facilities for a kitchen; dining, lounge, television, recreation, games, and laundry rooms; and storage. The complex also would have a first-aid and medical facility. The preconstructed modules would be double-stacked and meet the appropriate State of Alaska fire, safety, and occupancy requirements. They would be placed on concrete foundations, overlying cut-in weathered bedrock or compacted fill, and would be insulated to preserve the permafrost, if present.

Each dormitory room would contain two beds and be double-occupancy during the construction phase, giving a total camp capacity of approximately 500 persons during construction and 250 during operations. Washrooms and showers would be centrally located. Enclosed walkways would connect the accommodation complex to the dining facilities and to the worker's drying shed, offices, shops, and warehouse building.

The existing exploration camp near the 1525 exploration portal in the Goodpaster Valley would be expanded to accommodate approximately 200 workers during the construction period. This camp would be removed after startup.

2.3.22 Communications

The primary methods of communication in the mine, mill, shops, and camp would be on-site telephone systems, intercoms, and radios. All radio and telephone communications would be coordinated through the main security office. Responses to emergency situations and routine warnings for conditions such as blasting and hazardous materials transportation would be communicated through the security department.

2.3.23 Workforce

The mine and mill would be staffed and operated 24 hours per day, 365 days per year. The 2,500-tpd operation would require approximately 288 employees, of whom 172 would work in the mine department, 23 in management and administration, 70 in the mill and maintenance departments, and 23 as contract employees. At 3,500 tpd, the project would employ approximately 360 employees, of whom 215 would work in the mine department, 29 in management and administration, 86 in the mill and maintenance departments, and 30 as contract employees.

Operations and mining personnel are expected to be recruited from the workforce that lives in the Delta Junction and Fairbanks areas. Managerial and technical personnel necessarily would be recruited more widely. Table 2.3-5 presents the preliminary annual operations staffing for both the 2,500- and 3,500-tpd scenarios.

Because the relatively remote project site would make daily commuting impractical, a permanent camp would be constructed on site, and employees would rotate in and out on buses or aircraft in accordance with their shift schedules. Mill, maintenance, and underground staff likely would work a 4-day-on and 4-day-off rotation. Supervisory staff would generally be assigned to a 4-day-on and 3-day-off rotation. Personnel on rotations would share rooms with employees on the opposite rotation. Additional rooms would be allocated for contract and other personnel temporarily on site.

Table 2.3-5 Preliminary Annual Operations Staffing

	Classification	2,500 tpd	3,500 tpd
Process Plant	Supervision	10	12
	Technical labor	4	7
	Operating labor & trainees	16	22
	Maintenance labor	10	12
	Subtotal Process Plant	**40**	**53**
Mining	Production & development	31	44
	Haulage	8	10
	Construction	2	2
	Mining services & trainees	21	25
	Maintenance services	25	27
	Subtotal mining	**87**	**108**
	General & administration	17	21
	Engineering and Geology	15	19
	Total on-site employees	**159**	**201**
	On-site contractors (including catering, housekeeping, underground drilling, security)	12	17
	Total on-site personnel	**171**	**218**
	Employees on rotation	117	142
	Total employment	**288**	**360**

2.3.24 Surface Disturbance

The project footprint, as shown in Figures 2.3-1 through 2.3-1 e for the mine site, and Figure 2.3-2 for the access route, may be defined as that area on which surface disturbance would occur during the project's life. The overall project footprint would be composed of several individual project components. Although this Section 2.3 describes only the Applicant's Proposed Project, Table 2.3-6 presents the acreage of estimated surface disturbance, grouped by project component and option, associated with all three of the action alternatives (Alternatives 2, 3, and 4). This presentation has been made here for clarity because it would be confusing to show the Alternatives 3 and 4 (which are not the Applicant's Proposed Project) disturbance figures in separate tables in other sections of the document.

The Applicant's Proposed Project site plan, shown in Figures 2.3-1 through 2.3-1 e, and Figure 2.3-2 for the access route, was used to generate the estimated acreages of surface disturbance for Alternative 2 as shown in Table 2.3-6. The acreages shown in Table 2.3-6 for Alternatives 2, 3, and 4 are the same as those that were shown in the DEIS. Since that time, however, based on the agencies' Preferred Alternative as presented in the DEIS, public comments on the DEIS, further engineering refinements and more detailed design, and on-going discussions with the agencies, the project that the Applicant actually expects to construct, if it receives the necessary authorizations, has changed slightly. Therefore, to present the most likely up-to-date acreage disturbance figures, the last column in Table 2.3-6 contains the estimated surface disturbance that would occur from construction of the agencies' Preferred Alternative.

Table 2.3-6 Approximate Existing and Expected Surface Disturbance for Each Alternative

Component / Option / Sub-option	*Existing Disturbance*	*Expected Disturbance (Alternative)*			
		2	*3*	*4*	*Preferred*
Mill and Camp (Liese Creek)					
► Basic mill, shop, camp, laydown, rock storage, solid waste, and growth media stockpiles	0	79.7	79.7	79.7	75.2
► Gravel source (including rock quarries)	0	11.6	11.6	11.6	13.9
► Power line Bridge to Mill	0	12.0	12.0	0.0	13.4
► Power[1]	0	0.1	0.1	0.1	0.1
Subtotal	*0*	*103.4*	*103.4*	*91.4*	*102.5*
1525 Portal Area (Goodpaster Valley)					
► Advanced Exploration Camp, construction facilities, fuel storage	22.4	33.7	33.7	33.7	27.7
► Gravel source (including Valley Borrow Area)	4.3	32.0	32.0	32.0	32.4
► Laydown area	0	15.9	15.9	15.9	11.0
Subtotal	*26.7*	*81.6*	*81.6*	*81.6*	*71.0*
Airstrip Facility (Goodpaster Valley)					
► Airstrip, batch plant, aviation fuel, growth media, and access	0	55.5	55.6	58.9	76.6
► Gravel source[2]	0	22.3	22.3	9.2	3.9
► Laydown area[3]	0	23.9	28.3	40.5	20.6
► Fuel storage[4]	0	0	1.6	6.1	1.6
Subtotal	*0*	*101.7*	*107.8*	*114.7*	*102.8*
Tailings Treatment Facility (Liese Creek)					
► Dry stack tailings pile, RTP, ditches, and related facilities	0	108.5	108.5	108.5	107.8
Subtotal	*0*	*108.5*	*108.5*	*108.5*	*107.8*
Treated Wastewater Discharge (Goodpaster Valley)					
► Soil absorption system	0	4.4	0	0	0
► Direct discharge to Goodpaster River	0	0	0.5	0	0
► Off-river treatment works[5]	0	0	0	13.1	13.1
Subtotal	0	*4.4*	*0.5*	*13.1*	*13.1*
All Mine Site Facilities *Subtotal[6]*		*426.3*	*428.5*	*436.0*	*423.9*
Surface Access					
► All-season road ROW from Shaw Creek and Goodpaster River divide to Goodpaster River Bridge (common to all alternatives)	0.3	71.9	71.9	71.9	81.7
✦ Material Sites for this common segment	0	17.3	17.3	17.3	17.2
► Shaw Creek Hillside all-season road ROW, camps, airstrips	2.3	429.7	0	0	444.1
✦ Material Sites for Alternative 2	22.9	225.6			201.3
► South Ridge all-season road ROW, camps, airstrips	0.4	0	554.7	0	0
✦ Material Sites for Alternative 3	1.2	0	121.8		0
► Shaw Creek Flats perennial winter trail ROW, camps, airstrips	56.1	0	0	330.3	31.0
✦ Material Sites for Alternative 4	0	0	0	118.1	0
Surface Access *Subtotal[6]*		*770.0*	*767.6*	*594.0*	*777.9*
Power Line					
► Shaw Creek and Goodpaster River divide to Goodpaster River Bridge ROW (common to Alternatives 2 and 3)	0.6	62.1	62.1	0	80.6
► Shaw Creek Hillside ROW (with all-season road)	0.5	539.2	0	0	505.8
► South Ridge ROW (with all-season road)	2.4	0	460.0	0	0
Power Line Subtotal[6]		*602.4*	*525.1*	*0.0*	*587.5*
Mine Facilities / Surface Access / Power Line Total[6]		***1,798.7***	***1,721.2***	***1,030.0***	***1,789.3***
► Tenderfoot Richardson Highway egress option	0	43.0	0	0	0
► Shaw Creek Hillside power line ROW (with winter only access)[7]	0.2	0	0	599.7	0
► Goodpaster Winter Road[8]		31.7	31.7	31.7	31.7
Grand Total[6]		***1,873.4***	***1,752.9***	***1,661.4***	***1,821.0***

1 Transformer (power line option) or generators (on-site generation option) require same area.
2 Alternative 4 value reflects 13.1 fewer acres of gravel extraction because same volume of gravel would be excavated for development of the off-river treatment works (see footnote 5).
3 Alternative 4 value reflects winter only access option need to store a year's materials and supplies.
4 Alternative 3 value reflects on-site power generation option with all-season road. Alternative 4 value reflects winter only access and need to store a year's fuel supply.
5 This option would disturb approximately 13.1 acres, and its excavation would produce gravel (see footnote 2)
6 Includes existing disturbed acreage from column 2.
7 Although Alternative 4 by definition has on-site power generation, the winter only access option could be paired with a power line as the Preferred Alternative. In that case, the Shaw Creek Hillside power line route would be used.
8 Used during first two winters of project development for all alternatives.

Because the Preferred Alternatives' disturbance acreage figures in Table 2.3-6 are very close to those shown for Alternative 2, and generally somewhat lower, this FEIS uses the same acreage values in its impacts discussions as were used in the DEIS for two reasons. First, the function of an EIS is to analyze the relative impacts between alternatives, and the small difference between Alternative 2 and the Preferred Alternative would not materially affect any of the analyses. Second, the Preferred Alternative acreage disturbance figures in Table 2.3-6 are based on the detailed COE Section 404 (wetlands) public notice which is contained in Appendix B of this FEIS. Therefore, the public notice drawings and disturbance acreages present the most detailed picture of what would actually be constructed if the Applicant receives the necessary authorizations.

In reviewing the COE Section 404 public notice in Appendix B it will become obvious that some acreage figures are substantially less than those shown in Table 2.3-6. This is because by its nature Section 404 and the public notice are concerned only with wetlands that fall under the COE's restricted jurisdiction, which results in differences between disturbance acreages shown in Table 2.3-6 and the Section 404 pubic notice. For example, clearing trees and brush for the power line across wetlands that would not actually break the ground surface does not fall under Section 404 jurisdiction because a "fill" would not occur. This FEIS, however, has used a more expansive definition of disturbance, and such clearing is included in Table 2.3-6 to give the reader a complete view of all impacts that would occur.

Because some project components would be constructed on or would partially cover existing disturbed areas, Table 2.3-6 also shows the existing disturbed acreage that would be occupied by a particular component. At the bottom of the table, the additional acreage that would be disturbed if the Tenderfoot Richardson Highway egress sub-option were selected for the Shaw Creek Hillside all-season road option is shown. Also shown there are the 31.7 acres of disturbance that would occur for all alternatives from construction of the Goodpaster Winter Road during the first two winters of project development.

2.3.25 Mine Safety

The mine area roads and power line clearing over Pogo Ridge would serve as wildfire breaks. The heavy equipment listed in Table 2.3-4 would be available for fire control and suppression, and would be able to quickly construct firebreaks. Automatic fire-suppression systems would be installed on all heavy equipment, and manual fire extinguishers would be installed in all small vehicles. Buildings would have sprinkler systems installed where appropriate, and all buildings would have fire extinguishers mounted on the walls.

The federal Mine Safety and Health Administration (MSHA) is the regulatory agency with oversight authority for underground and surface mining. The federal metal and nonmetallic mine safety and health regulations and the Applicant's corporate practices and policy require mandatory training for all full-time employees. In addition to training full-time employees, the project's operators would require that all visitors, vendors, and contractors review a "hazard recognition" information bulletin and sign a form acknowledging that they have read and understand the hazards associated with mining.

New-hire underground mine employees would be required to complete a 40-hour mine-safety and hazard-recognition training program before reporting to their assigned work areas. New-hire surface employees would receive a 24-hour mine-safety training program. All full-time employees also would be required to attend an 8-hour annual refresher course.

Fire brigade and mine emergency response teams would be trained and certified to respond to emergency situations, including forest fires that might threaten the project site. The Applicant would provide training opportunities for certification of employees in mine rescue and advanced technical training for hazardous material incidents, and as medical first responders, emergency medical technicians, and hazardous material incident first responders.

2.3.26 Fish and Wildlife Protection

Applicant and contractor employees transported to project facilities during construction or operation for purposes of work and individuals otherwise on site would not be permitted to hunt, trap, or fish in the area. Employees wishing to hunt or fish would have to return to their point of origin after their shift and return to the area by their own means. They would not be permitted to return via either the all-season access road or the airstrip. No hunting at all would be permitted by *anyone* in the immediate vicinity of project facilities, including the public, for worker safety reasons. Employees on duty or commuting to or from the mine site would not be permitted to operate non-company all-terrain vehicles (ATVs), snow machines, watercraft, or aircraft to, from, or within the mine site facilities.

The following policies would be included in an employee education program that would be implemented:

- Feeding animals would be strictly prohibited.
- Employees would be instructed in proper food handling and garbage disposal techniques, the personal dangers involved in feeding animals, and the fact that animals often end up being shot when they lose their fear of people and become dangerous.
- Every employee would receive formal instruction on how to avoid attracting and confronting bears. This instruction would include:
  - Reading a handout that spells out the Applicant's bear policies and specifically lists forbidden activities (e.g., feeding wildlife, tossing out lunch wrappings and juice cans, and harassing wildlife), and the risks of engaging in those activities (mauling and rabies).
  - Watching a video on how to avoid and react to bear encounters.
  - Reading the ADFG *Bear Facts* pamphlet.
- Employees would be instructed that if a bear is shot for reasons attributed to feeding of animals or the improper disposal of food away from camp, and the individual(s) can be identified, they would be disciplined.
- Employees would be instructed that any bear not shot in defense of life and property would be considered a violation of the Applicant's no hunting policy, the individual(s) would be disciplined, and the matter would be turned over to the Alaska State Troopers for investigation.
- Employees would be required to sign a statement affirming the employee understands the Applicant's animal feeding and bear policies and the consequences of violating those policies, including possible dismissal.

The Applicant would develop and maintain human-wildlife contact protocols addressing:

- How to react to the presence of a bear that remains in the project area, whether attracted by food, garbage, or for some other reason.

- When specific actions are needed, what actions should be taken, by whom, with what equipment, where it is stored, and what role (if any) agency personnel should play (e.g., ADFG).
- Applicant and agency personnel to be contacted for assistance or to report an incident.

2.3.27 Mine Closure and Reclamation

The goal of the closure and reclamation plan would be to return disturbed land to the designated post-mining land use, defined by the State's TBAP as public recreation and wildlife habitat (ADNR, 1991). The goal of reclamation would be to re-establish wildlife habitat within 5 to 15 years by stimulating the growth of early successional vegetation. This vegetation would provide willow and shrub browse for moose and other game; young aspen stands for ruffed grouse habitat; and grass areas that would provide forage, diversity, and cover for voles and food for raptors.

The primary objective of the closure part of the plan would be to ensure that water quality would not be strongly affected after mine closure. To accomplish this objective, materials that potentially could cause degradation to the lands and waters of the state would be stabilized, removed, or mitigated.

The primary objective of the reclamation part of the plan would be to stabilize disturbed mined-land surfaces against erosion. This stabilization would be accomplished by improving plant growth conditions and encouraging the succession of self-sustaining native and naturalized plant communities. Inactive areas not anticipated to be disturbed would be closed and reclaimed concurrently with mining.

A summary of the proposed closure and reclamation plans for project facilities is presented below. Specific mining and reclamation plans are presented in the *Pogo Project Reclamation and Closure Plan* (Teck-Pogo Inc., 2002c).

Mill and Camp Complex

The following closure activities would be performed upon completion of mill operations and termination of mining and production activity:

- All process liquids would be treated and sent to the recycle tailings pond. Any wastewater would be treated and discharged in a manner permitted by the regulatory agencies.
- Hazardous and toxic materials such as reagents, petroleum products, acids, and solvents would be moved off site by licensed transporters for return to vendors or disposal at licensed facilities.
- Process equipment and structures would be removed from site and sold as salvage.
- Remaining structures such as the mill, camp site, and ancillary facilities and foundations not removed off site would be disposed of in accordance with ADEC solid waste regulations. For example, depending on the item, it might be burned, crushed, or dismantled and buried on site.
- The ground surface of the mill site and other ancillary sites would be ripped where the surface were compacted, recontoured, and stabilized as required for the post-mining land use of the site.

Tailings Dry Stack

After appropriate contouring to control runoff, the tailings dry stack would be capped with an engineered soil cover system to provide a medium for establishing a sustainable vegetation cover that would be consistent with the post-mining land use designation

Runoff water from upstream in the watershed would be diverted around the tailings dry stack in permanent diversion channels. Any long-term discharge from the dry stack would be monitored and treated as necessary in consultation with the regulatory agencies.

Adit, Shaft, and Underground Workings

The three adits and two ventilation raises would be permanently stabilized and sealed with concrete. The mine workings would be allowed to flood and groundwater levels to recover toward pre-operational levels. The mineralized wall areas and the cemented backfill would be below the water table, thereby reducing or eliminating the oxidation of sulfides.

Rock and Overburden Storage Piles

Preliminary characterization of waste rock indicates there is no net acid generation potential from the nonmineralized material that would be placed in storage piles (Teck-Pogo Inc., 2002b; Appendix C, p. 16 and Table 5). Stabilization of the nonmineralized piles would follow BMPs to minimize water runon and runoff while providing adequate growth medium to establish a vegetative cover.

Routine characterization of material produced during mine life and at closure would determine final stabilization methods. Materials that could result in the potential for net acid generation would be classified as mineralized material and buried within the tailings dry stack.

Any material that would be disturbed and that had the potential to be classified as growth medium, such as overburden and topsoil, would be stockpiled for future use. These stockpiles would be seeded to prevent erosion and preserve the plant growth conditions.

It is proposed to amend some of the overburden material by mixing with downed brush and trees from clearing activities. This amended material would be expected to have several advantages: provide nitrogen and nutrients as decomposition products; supply seeds, roots, and micro-organisms needed to re-establish native vegetation; and contribute woody debris for habitat enhancement.

After cessation of active mining, material from the overburden stockpiles would be used as a growth medium where necessary. Overburden stockpiles of material not designated to be used as growth medium in other areas would be seeded and stabilized during mining.

RTP Dam

Upon cessation of mining and milling, the RTP water storage dam constructed in the upper Liese Creek would be reclaimed after it was no longer required for water treatment. The cut-and-fill slopes would be graded to blend with the surrounding topography. Small areas of depression would be created to hold snow and precipitation, and willow or alder thickets would be established.

Access and Site Roads

All bridges would be removed from the main access road and the roadway would be reclaimed. On-site access and service roads not specifically required for post-closure and reclamation monitoring would be reclaimed. Roads necessary for monitoring would be sloped and water-barred to minimize erosion and prevent the formation of rills.

Power Transmission Lines

Power transmission lines to the project site and distribution lines to the mine, mill, and ancillary facilities would be dismantled when no longer necessary for closure operations. Electric cables, poles, supports, insulators, transformers, and other equipment and materials would be removed and sold for salvage.

Airstrip

Once the bridge across the Goodpaster River was completed, the existing gravel bar airstrip in the valley bottom would become unusable, and would be reclaimed by removing airstrip markers and spreading woody debris such as logs and stumps to ensure it would not be functional.

The 3,000-ft airstrip would not be reclaimed immediately after project shutdown because it would be used for post-closure and reclamation monitoring. Once monitoring was completed, the airstrip would be either reclaimed or left as is, depending on direction from the landowner, the State of Alaska.

Water and Monitoring Wells

After final closure, water pump-back and production wells would be abandoned and plugged in an approved manner. All sumps, ponds, and drains associated with pump-back wells would be filled, contoured, seeded, or stabilized to meet the requirements of the designated post-mining land use.

Monitoring wells not used for post-closure compliance monitoring would be abandoned and plugged in an approved manner. Compliance monitoring wells would be maintained and secured to prevent tampering until the monitoring requirements were satisfied. They then would be abandoned and plugged.

2.3.28 Monitoring

Ultimate monitoring plans for post-closure would be developed in conjunction with state and federal agencies. The principal objective of water quality monitoring, however, would be to protect water quality in the Goodpaster River. The three major components of the water quality monitoring plan would be to monitor the:

- Operating performance of the SAS
- Water that is near, but has not yet reached, the Goodpaster River
- Water in the Goodpaster River

This monitoring would involve sampling wells on the perimeter of the SAS to monitor its performance to provide early feedback, enabling response and mitigation as needed before there was a compliance problem at downgradient wells. Monitoring wells downgradient of the SAS would be monitored on a monthly basis to determine water quality and elevation trends and to sample the water before it reaches the river. A groundwater well located upgradient of the SAS field also would be monitored. Background sampling is currently under way at these sites and would continue after discharge to the SAS commences.

Test procedures would follow EPA or other approved methods. The quality assurance and quality control program currently in place for the advanced exploration program would be continued and expanded as necessary. A more detailed water monitoring plan would be included with the State of Alaska solid waste application for the dry-stack tailings area, RTP pond, and SAS.

The results from compliance monitoring would be reported to the appropriate agencies on a monthly basis following discharge to the SAS. If there were an anomalous value of concern, it would be addressed as outlined in the monitoring plan. Quarterly data reports would include electronic data and graphical presentation for trend detection.

2.3.29 Contingency Planning

If the conditions encountered during mine operations were to vary substantially from those predicted, alternative plans might have to be implemented. Although developing detailed plans to address every conceivable potential problem would be impractical, developing certain plans makes sense, e.g., mine inflow contingency plan (Teck-Pogo Inc., 2002b). In addition, the Applicant has incorporated certain design features and management strategies in planned facilities that would improve the flexibility of the systems to respond to different or changing conditions. These include:

- Bleed stream treatment and management for the mill process
- Design features of the water treatment plant that improve flexibility
- Instrumentation, control, and upset management for water treatment
- Water treatment plant changes to meet reduced arsenic limits of 10 parts per billion (ppb)

2.3.30 Project Shutdowns

At some point during the life of the mine, project operations likely would be shut down for one or more short periods (less than 3 months). Short-term shutdowns occur due to events such as major equipment breakdowns or weather-related interruptions. Long-term, but still temporary (between 3 months and 3 years) shutdowns usually only occur in response to economic changes, such as a prolonged decline in the price of gold. Long-term shutdowns are much less likely to occur. Permanent shutdown would occur at the end of the mine life.

Short-Term Shutdown Plan

During a short-term shutdown, the following activities and other maintenance procedures would keep the facility in good operating order until the interruption(s) were remedied and operations were ready to resume:

- Continue to treat and discharge water as normal
- Continue normal maintenance of ditches

- Shut down mill and filter plant and prepare to resume operations as soon as mining recommences
- Shape stockpiles to minimize erosion

Long-Term Shutdown Plan

In the event of a long-term shutdown, a minimum staff would continue to maintain and preserve the facility until it could be restarted. Long-term shutdown practices would allow the mine and plant to be restarted after a commissioning period during which equipment would be reassembled and restarted, reagents reintroduced, electrical and control systems re-energized, and production activities resumed. A long-term shutdown of the Pogo project would involve the following activities:

- Draw down the RTP to a minimum volume
- Treat and eliminate all process solutions
- Shut down the mill and filter plant, draw down all process tanks and vessels, and mothball major equipment to preserve its mechanical condition
- Flush and clean all process lines and instrumentation, and protect all electronics and sensitive equipment
- Secure the mill, filtration plant, and mine, and continue to treat water as necessary
- Implement contingency plans to limit mine water inflows to below 150 gpm
- Install erosion protection on all stockpiles, dumps, and site areas

2.3.31 Development Schedule

Based on current timelines, the Pogo project would be constructed during a 2-year period beginning soon after permits were received, possibly in the latter half of 2003. The timing and sequence of construction would depend on the date of project approval. The main construction philosophy for the project would to mobilize camp facilities, surface earthmoving equipment, underground equipment, and supplies to the site as soon as possible over the Goodpaster Winter Trail. This mobilization activity would allow the site surface and underground work to be started prior to completion of the all-season access road. It also would allow the access road to be constructed from both ends.

Two construction camps would be built on site, and temporary camps would be installed along the access road and power line. Construction would proceed year-round as follows, with production commencing approximately the end of 2005:

- Major construction equipment and materials would be staged at the Richardson Highway and Delta Junction.
- As soon as possible after project approval, the site road from the 1525 Portal to the plant site in Liese Creek and to the new airstrip would be constructed with equipment currently on site.
- The 3,000-ft airstrip would be built as soon as possible after project approval.
- A winter road would be built on the Goodpaster Winter Trail in December 2003 to permit construction equipment, materials, and road-building equipment to be transported to the site.

- When the winter road access would become available, the existing exploration camp below the 1525 Portal would be expanded to accommodate 200 people, and temporary construction facilities would be established.
- Aggregate gravel pits would be opened and production would start as soon as possible. The off-river treatment works would be constructed in some of the borrow pits and would be completed within 12 months of project startup.
- Construction on the Shaw Creek Hillside all-season access road would begin as soon as possible after project approval. A second construction heading would be established at the Pogo Mine site end after completion of the winter road. If permit approval were received in time for the Shaw Creek Flats winter road/trail to be used, an additional double construction heading would be established near Gilles Creek. The access road likely would take 8 to 12 months from start of construction to final completion.
- Construction on the 138-kV power line would lag behind road construction to ease congestion and limit the size of working areas.
- Underground development would begin as soon as possible, using the existing exploration adit for access. The 1690 and 1875 adits, the underground ore handling system, and the delivery conveyor would be developed and installed during the subsequent 18 months.
- Site preparation and concrete work would begin in the summer of 2004. The main construction/operations camp in Liese Creek Valley would be built during this period to provide accommodation at the site for the construction workforce.
- The major buildings would be erected by the winter of 2004-2005 so that work could continue within a protected shell.
- Assuming timely construction of the pioneer all-season road, additional materials and equipment would begin arriving on site in late 2004. If road construction were delayed, these materials could be transported over a second winter road on the Goodpaster Winter Trail beginning in December 2004.
- The RTP dam and other earthworks would be constructed during the spring, summer, and fall of 2005.
- The remaining mechanical, piping, electrical, and instrumentation work would be done in sequence throughout 2005, with mill completion and startup planned for late 2005.

2.3.32 Changes Following DEIS Comments

As a result of public and agency comments on the DEIS, two relatively small changes in project configuration have been considered in this EIS. While all of the preceding information in this Section 2.3 presents the Applicant's original Proposed Project, this subsection describes these two changes because this is the logical location to present such material.

Tailings Dry Stack

In the Applicant's Proposed Project, the only organic material to be removed prior to depositing tailings in the dry stack footprint is from the area of the flow-through drains. The structural stability analysis indicated the toe berm of the structural shell would provide sufficient confinement to preclude any potential for dry-stack instability, and that further clearing of organic matter from the dry stack footprint was unnecessary. Thus, in the Pogo Reclamation Plan (Teck-

Pogo Inc.,2002C), the Applicant did not assume any growth media would be salvaged from the dry-stack area.

In reviewing the reclamation plan, the State raised two issues with respect to the topsoil and growth media in the dry-stack area. The first suggested the Applicant show that the dry-stack facility would be geotechnically stable without topsoil removal. The second suggested the overall growth media balance might turn out to be negative under certain circumstances, and questioned if there were sufficient contingency areas from which to obtain adequate volumes. In response to these concerns, a slightly modified construction approach for the dry-stack facility has been considered. The only substantive changes would be to clear, grub, and stockpile approximately 1 foot of organics and mineral soil from the entire dry-stack footprint, totaling approximately 40,000 cubic yards, and subsequently place an approximately 1.5 feet deep nonmineralized rock erosion control/drainage blanket (approximately 87,500 tons) of over the entire dry-stack facility footprint.

Power Line Route

In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option has been considered with the power line following the road corridor over the divide.

2.4 Issues, Options, and Screening

This section describes the issues identification, options development, and options screening processes for the Pogo Mine project. It includes three subsections, each describing one process.

Section 2.4.1 (Issues Identification) discusses how scoping comments were analyzed to determine the 17 scoping issues raised by the public and agencies, and identifies those issues.

Section 2.4.2 (Options Development) identifies the component options that were considered to address those scoping issues, and then describes them.

Section 2.4.3 (Options Screening Process) summarizes the process by which the options identified in Section 2.4.2 were screened against the options evaluation criteria. As a result of this process, those options best suited to address the scoping issues were retained for detailed impacts analysis in Chapter 4, and the other options were dropped from further consideration.

2.4.1 Issues Identification

An important first step in preparing the EIS is "scoping." Scoping is a public participation process intended to have all interested parties assist EPA and cooperating agencies in identifying issues of concern associated with the proposed Pogo Mine project. The process is designed to help ensure that all potentially significant issues are properly identified and fully addressed during the course of the EIS process.

The main objectives of the scoping process are to:

- Provide the public, Tribes, and regulatory agencies with a basic understanding of the proposed Pogo Mine project

- Explain where to find additional information about the project
- Provide a framework for the public to ask questions, raise concerns, identify specific issues, and recommend options other than those proposed by the Applicant
- Ensure that those concerns are included within the scope of the EIS review process

How Scoping Proceeded

On August 11, 2000, EPA distributed the *Scoping Document for Pogo Mine Project Environmental Impact Statement*. That document:

- Presented a schedule for the scoping process
- Described the scoping open houses held in September 2000
- Identified where additional information about the proposed project could be obtained
- Explained the roles of EPA, COE, and ADNR in the EIS and permitting processes
- Described the EIS process after scoping and presented a tentative EIS schedule
- Presented a brief summary of the Applicant's proposed project as well as more specific details for each component of the proposed project
- Described other component options and issues that were already identified by the public and agencies that will be considered during the EIS process

Distribution of the scoping document began a 60-day public and agency review and comment period that ended on October 10, 2000. EPA hosted two scoping open houses during that period. The first was held on September 26, 2000, in Delta Junction at the Delta Junction Community Center, and the second was held on September 27, 2000, in Fairbanks at the Noel Wien Library. Attendance was 46 and 50, respectively.

The scoping open houses served two purposes. One was to listen to and record the public's comments about the proposed project as described in the scoping document. The second was to respond to the public's requests for the background information and hands-on technical assistance they might need to fully understand the project description and proposed scope of the EIS analysis before commenting. EPA project staff and members of the third-party contractor, Michael Baker, Jr., were available to answer questions and explain methodologies.

A "town meeting" format at each evening's end provided an opportunity for individuals to comment and promoted group interaction. All comments made during the open houses, whether oral or written on comment sheets or flipcharts, were documented as part of the official record. While people were welcome to make comments and suggestions during the open houses, the record was specifically left open for an additional 13 days to accommodate anyone needing additional time to formulate comments.

Government-to-Government Consultations

In addition to the EIS scoping effort, pursuant to Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments) EPA has undertaken a concerted government-to-government consultation effort on the Pogo EIS project with the 13 Tribes listed below that are considered to be potentially affected by the proposed Pogo Gold Mine by virtue of their location (1) within a 125-mile radius of the proposed Pogo Mine site or (2) within the potentially affected Tanana River watershed.

Under EPA's government-to-government consultation plan, the first consultation was held in the village of Healy Lake between EPA and the Healy Lake Tribal Council on September 25, 2000. Then, all 13 Tribes were invited to attend in person or by teleconference the first in a proposed series of government-to-government consultations on the subject of the Pogo EIS on September 26, 2000, in Delta Junction. A telephonic government-to-government consultation also was convened on November 9, 2000.

- Circle Native Community
- Dot Lake Village Council
- Healy Lake Tribal Council
- Manley Village Tribal Council
- Mentasta Traditional Council
- Native Village of Eagle
- Native Village of Minto
- Native Village of Tanana
- Nenana Native Village
- Northway Traditional Council
- Tanacross Village Council
- Tetlin Village Council
- Tok Traditional Council

Scoping Comments

All comments received during the scoping process, whether written in letters, on comment sheets, on flipcharts at the open houses, transcribed from oral testimony at the open houses, or received during government-to-government consultations, were read and categorized into the issues discussed below. Many commenters raised several issues, and each was considered.

Sixty-two sets of comments were received, excluding those received during government-to-government tribal consultations. In five of these cases, individuals gave very similar comments on two or more occasions, usually orally and in writing. Thus, 57 individual sets of non-tribal comments were received. Because some written comments were signed by more than one individual or organization, 64 entities actually commented. An approximate breakdown by general non-tribal commenter group is shown below.

Individual members of the public	48
Municipal governments	1
Non-government organizations	8
State and federal agencies	7
Total	64

During the government-to-government consultations described above, comments were solicited from 13 Tribes and two regional Native non-profit organizations during the scoping process. All comments received are considered in this EIS.

A fully representative selection of tribal, agency, and public comments, as well as a comprehensive listing of all issue-related comments raised in government-to-government tribal consultations, were distributed to all interested parties in the *Pogo Mine EIS Responsiveness Summary* on January 30, 2001 (EPA, 2001a).

The majority of comments related to issues predominantly associated with access to the mine. They included the type of access (all-season road versus a winter road/trail), the access route, how a road should be managed when in use, and what a road's disposition should be after mine closure. A substantial number of other issue comments also were related directly or indirectly to access. Thus, the type of access, the route, issues associated with management and disposition of a road, and a road's effects on surrounding land uses and resources were of overwhelming concern to commenters.

Other issues of particular concern that were identified include water (water quality and water management), wildlife, fish, wetlands, subsistence, cultural resources, and employment. Many of these comments concerned access-related impacts on these resources. Many comments fell into the category of land use changes that could occur if an all-season road were to be constructed. These land use changes included increases in timber harvesting, recreational use, and competition for subsistence resources.

Other issues, while still important, were not the subject of as many comments as the issues cited above. Several of the issues, however, were considered important enough to become formal scoping issues (e.g., cumulative impacts, air quality, noise, and safety).

Identification of Issues and Evaluation Criteria

Issues identification is the process by which the key concerns raised during scoping were determined. These issues then were turned into specific criteria that were used to evaluate the various options and sub-options for each component of the proposed project. Analysis of the comments received during the Pogo Mine EIS scoping process was the important first step in this identification process. The comments received during the scoping process were individually analyzed and fell roughly into three groups.

- **Informative.** These comments provided information to be considered during the EIS process. Examples included agencies stating their authority or jurisdiction over certain regulatory functions and making suggestions about how certain technical analyses might be approached as well as individual members of the public and tribal councils who provided resource and use information based on their experiences in the area. Information contained in these comments has been evaluated and is reflected in data reports, this EIS document, or during other aspects of the EIS process as appropriate.
- **Inquisitive.** These comments asked questions about the proposed project or about how the EIS process would proceed. Examples included specific technical queries (e.g., *Will individual mine workers be allowed to fly their own planes to work?*) and more broad process questions (e.g., *Is the State of Alaska proposing any changes in any of its current management plans or options to address these [timber harvesting] impacts?*). These comments were used as a checklist to ensure that these questions were addressed in this EIS.
- **Expressive.** This group contained the majority of comments, and, through statements or questions, expressed a wide range of project-related concerns. These comments are of particular importance to the scoping process because they document the public, agency, and tribal concerns about the project and form the basis for identifying the issues and developing the specific evaluation criteria that were used to screen the various project options, select the alternatives, evaluate the consequences, and identify a preferred alternative.

Issues and Evaluation Criteria

The scoping comments provided the basis for identifying the major issues of concern during construction, operation, and closure of the proposed project. The 17 issues identified from public scoping comments are listed below. Each issue (e.g., water quality, wildlife, and socioeconomics) was turned into a specific "evaluation criterion" that, in combination with the other criteria, was used to screen the various project component options and identify the alternatives to be considered for detailed analysis in the EIS. Each criterion is shown below under its corresponding issue heading.

Note: Because "impacts" can be both positive and negative, in this document the term "impacts" is construed to mean negative impacts while the term "benefits" is construed to mean positive impacts.

Issue 1. Surface and Groundwater Quality

Criterion: Maintenance of existing water quality in the affected drainages to fully protect all designated uses (such as aquatic life, drinking water, and industrial use).

Issue 2. Wetlands

Criterion: Siting, construction, and management of components to avoid, minimize, and mitigate impacts on wetlands.

Issue 3. Fish and Aquatic Habitat

Criterion: Minimization of impacts to fish and aquatic habitat.

Issue 4. Wildlife

Criterion: Minimization of impacts to wildlife and habitat.

Issue 5. Air Quality

Criterion: Minimization of impacts to existing air quality.

Issue 6. Noise

Criterion: Minimization of noise impacts to residents, recreationists, wildlife, and others.

Issue 7. Safety

Criterion: Minimization of safety issues for workers and members of the public.

Issue 8. Reclamation

Criterion: Components designed and sited to promote successful reclamation.

Issue 9. New Industrial and Commercial Uses

Criterion: Infrastructure for new industrial/commercial uses, such as logging, consistent with the management intent, guidelines, and land use designations of the adopted TBAP and the TVSF Management Plan.

Issue 10. Recreational Resources and Uses

Criterion: Access for recreational uses consistent with the management intent, guidelines, and land use designations of the adopted TBAP and the TVSF Management Plan.

Issue 11. Existing Privately Owned Lands and Existing Recreational and Commercial Uses

Criterion: Minimization of impacts to existing privately owned lands and existing recreational and commercial uses consistent with the management intent, guidelines, and land use designations of the TBAP and the TVSF Management Plan.

Issue 12. Subsistence and Traditional Uses

Criterion: Minimization of impacts to subsistence and traditional resource uses currently occurring within the affected area.

Issue 13. Cultural Resources

Criterion: Avoidance of impacts to cultural resources.

Issue 14. Socioeconomics

Criterion: Minimization of social and quality of life impacts and maximization of economic benefits to potentially affected communities.

Issue 15. Cumulative Impacts

Criterion: Assessment of the cumulative impacts from this and other past, present, and potential developments in the area.

Issue 16. Technical Feasibility

Criterion: Minimization of chances of system failure by incorporating technically feasible and operationally efficient component design, siting, and mitigating measures.

Issue 17. Economic Feasibility

Criterion: Consideration of the cost-effectiveness of technically feasible and operationally efficient component design, siting, and reclamation.

2.4.2 Options Development

Once the scoping issues identification process was completed, as described in Section 2.4.1 above, project component options were developed to provide an array of options that could address the specific concerns raised by the scoping issues. Subsection # 1 below presents, in outline format, the component options and sub-options that are considered in this EIS, and Subsection # 2 describes these options in greater detail.

Options Considered

In developing its proposed project, the Applicant considered several options for different components. In its *Pogo Project Conceptual Project Description* (Teck-Pogo Inc., 2000e), *Pogo Project Access Alternatives Study* (Teck-Pogo Inc., 2000b), *Pogo Project Description* (Teck-Pogo Inc., 2000a), and *Pogo Project Plan of Operations* (Teck-Pogo, Inc., 2002a), the Applicant discussed why it ultimately selected or rejected specific options to arrive at its proposed project. In addition to these options considered by the Applicant, other component options were suggested during scoping by the public, the agencies, the Tribes, and the third-party contractor. Still other options were identified by the agencies following review of the Preliminary Draft EIS (PDEIS).

From these sources, and based on the project's design criteria, Table 2.4-1 presents the 14 project components (shown in bold), 15 subcomponents (bold, italics), and more than 100 options and sub-options that were developed. An underline signifies the Applicant's proposed option or sub-option for a given component. Each option and sub-option listed immediately below is described in the following section (Section 2.4.2 Options Description). Each has been addressed in this EIS.

Table 2.4-1 Components, Options, and Sub-Options Considered in this EIS

An underline signifies the Applicant's proposed option or sub-option for a given component

Project Component	*Sub-components*	▶ Options	✦ Sub-options
Milling Process			
		▶ Whole ore cyanidation	
		▶ Gravity/flotation/cyanide vat leach	
		▶ Gravity/flotation/ship concentrate off site	
Tailings Disposal			
	Type		
		▶ Underground paste backfill	
		▶ Surface dry stack/recycle tailings pond (RTP)	
			✦ Lined dry stack
			✦ Lined RTP
			✦ Unlined dry stack
			✦ Unlined RTP
		▶ Traditional surface wet tailings placement	
	Location		
		▶ West side of Goodpaster River	
			✦ # 2 Traditional wet tailings
			✦ # 3 Traditional wet tailings
			✦ # 4A Dry stack
			✦ # 4B Dry stack
			✦ # 5 Dry stack
			✦ # 7 Traditional wet tailings
			✦ # 8 Traditional wet tailings
		▶ West side of Goodpaster River via tunnel	
		▶ East side of Goodpaster River	
			✦ # 1 Liese Creek dry stack
			✦ # 6A Lower West Creek wet tailings
			✦ # 6B Upper West Creek wet tailings
			✦ # 6C West Creek dry stack
			✦ # 9 Sonora Creek wet tailings
			✦ # 10 Tabletop dry stack
		▶ Off site (outside the project area)	
Mill and Camp Location			
		▶ # 1 Near existing 1525 Portal in Goodpaster Valley	
		▶ # 3 Upper Pogo Ridge	
		▶ # 4 Pogo Ridge	
		▶ # 5 West side of Goodpaster River	
		▶ # 6 Liese Creek Valley	
		▶ Off site (outside the project area)	
Development Rock Disposal			
		▶ Mineralized rock encapsulated in dry stack	
		▶ Nonmineralized rock in dry stack, in RTP dam, and for other construction	
Gravel Source			
		▶ Expand existing gravel pits and develop new pits in Goodpaster and Liese Creek valleys	
		▶ Crush nonmineralized development rock	
Construction Camp Location			
		▶ Below existing 1525 Portal in Goodpaster Valley	

Table 2.4-1 Components, Options, and Sub-Options Considered in this EIS

An underline signifies the Applicant's proposed option or sub-option for a given component

Project Component	*Sub-components*	▶ Options	✦ Sub-options	⏩ Sub-options
Laydown Areas				
		Permanent near existing 1525 Portal, adjacent to airstrip, and at mill		
		Temporary near existing 1525 Portal and adjacent to airstrip; permanent at mill		
Power Supply				
		On-site generation		
		Power line		
Water Supply				
	Industrial			
		Mine drainage		
		RTP		
		Wells		
		Goodpaster River		
	Domestic			
		Wells		
		Goodpaster River		
Water Discharge				
	Development Phase			
		Underground injection wells		
		Direct discharge to Goodpaster River		
		Off-river treatment works		
	Operations Phase			
		Industrial wastewater (RTP)		
			Constructed wetlands at borrow pit in Goodpaster River Valley	
			Soil absorption system	
				Goodpaster River Valley adjacent to airstrip
				Middle Liese Creek Valley
				Saddle above and southeast of Pogo Ridge
			Underground injection wells	
			Direct discharge to Goodpaster River	
			Off-river treatment works	
		Domestic wastewater		
			Underground drain field	
				Permanent in Goodpaster Valley near mouth of Liese Creek
				Temporary Liese Creek Valley; permanent below 1525 Portal
			Direct discharge to Goodpaster River	
Fuel Supply and Storage				
	Supply Route			
		All-season road		
			Shaw Creek Hillside	
			South Ridge	
		Winter-only access		
			Shaw Creek Flats	
			Goodpaster River Valley	
		Air-only supply		

Table 2.4-1 Components, Options, and Sub-Options Considered in this EIS

Project Component | ***Sub-components*** | An underline signifies the Applicant's proposed option or sub-option for a given component
- ▶ **Options**
  - ✦ **Sub-options**
    - ⏩ **Sub-options**

Storage Location
- ▶ Temporary below 1525 Portal and at airstrip; permanent at 1525 Portal mouth and mill
- ▶ Temporary below 1525 Portal and at airstrip; permanent only at the mill

Surface Access

Type
- ▶ All-season road
- ▶ Winter-only access
- ▶ Railroad

Route
- ▶ All-season road
  - ✦ Shaw Creek Hillside (Initial egress from Richardson Highway)
    - ⏩ Existing Shaw Creek/Rosa Road
    - ⏩ Pipeline
    - ⏩ Keystone
    - ⏩ Tenderfoot
  - ✦ South Ridge
  - ✦ Dean Cummings Crossing
- ▶ Winter-only access
  - ✦ Shaw Creek Flats
    - ⏩ To head of Shaw Creek Valley
    - ⏩ To south of Gilles Creek
  - ✦ Goodpaster River Valley
- ▶ Railroad
  - ✦ Goodpaster River Valley

Management
- ▶ Design
  - ✦ All-season road
    - ⏩ One lane with periodic turnouts
    - ⏩ Two lanes
  - ✦ Winter-only access
    - ⏩ Traditional winter road construction standards
    - ⏩ Perennial winter trail construction standards
- ▶ Use (during Pogo mine operations) – Road open (versus closed) to:
  - ✦ Pogo project only
  - ✦ Pogo and other industrial/commercial users only
  - ✦ Everyone
- ▶ Security gate location
  - ✦ Near end of Shaw Creek Road
  - ✦ At Gilles Creek

Disposition
- ▶ Remove and reclaim
- ▶ Convert to recreational trail
- ▶ Leave road open (versus closed) to:
  - ✦ Industrial/commercial users
  - ✦ Everyone

Table 2.4-1 Components, Options, and Sub-Options Considered in this EIS

Project Component	*Sub-components*	Options	Sub-options
Air Access			
	Type		
		Air-only access	
		As complement to surface access	
			3,000-ft airstrip in Goodpaster River Valley
			5,000-ft airstrip at Tabletop (above and east of Liese Creek Valley)
		No air complement to surface access	
	Management		
		Airstrip open (versus closed) to:	
			Pogo project only
			Pogo and other industrial/commercial users
			Everyone
	Disposition		
		Remove and reclaim after mine reclamation	
		Leave airstrip open (versus closed) to:	
			Industrial/commercial resources
			Everyone
Power Line Route			
		All-season road	
			Shaw Creek Hillside
			South Ridge
		Winter-only access	
			Shaw Creek Hillside
			Goodpaster River Valley

Note: An underline signifies the Applicant's proposed option or sub-option for a given component.

Options Description

The options and sub-options for each of the 14 project components identified in Table 2.4-1 (above) are described below. The reader is strongly encouraged to frequently refer to the list of options and sub-options in Table 2.4-1 immediately above for context when reading the following descriptions.

Milling Process

Three mill process options were considered. In two options, cyanide would be used to leach gold from the flotation concentrate inside the mill, while the third option would not use cyanide on site.

- Whole ore cyanidation In this option, all the ore would be leached with cyanide. All the tailings would undergo a cyanide destruction process, but any tailings deposited in either a traditional surface disposal impoundment or in a dry tailings stack would have been exposed to cyanide.

- Gravity/flotation/cyanide vat leach In this option, after gravity separation, flotation would be used to produce a concentrate that would be 10 percent of the total ore weight.

The concentrate would be leached in cyanide vats to recover the gold, and all of the leach tailings would be placed underground as paste backfill after cyanide detoxification. The flotation tailings deposited on surface in the dry-stack facility would not have been exposed to cyanide.

- Gravity/flotation/ship concentrate off site This option would be the same as immediately above, but cyanide would not be used on site. The ore concentrate would be shipped outside the project area for processing.

Tailings Disposal

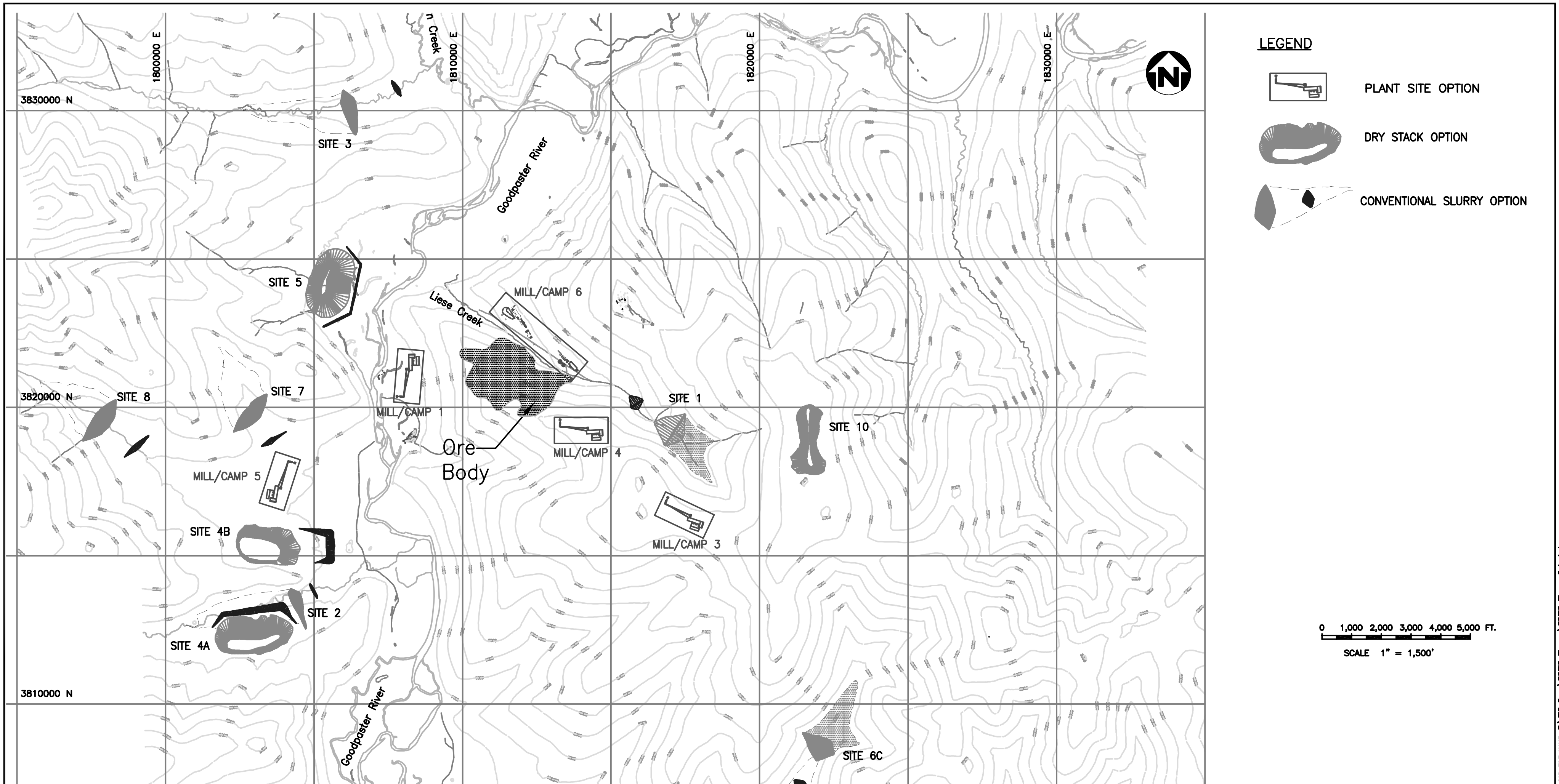
This component had two subcomponents: type of disposal and location of the disposal.

Type Three tailings disposal options were considered: underground in the mine as a paste backfill, stacked dry on the surface, and traditional placement in a surface pond for settlement behind a dam.

- Underground paste backfill In this option, approximately half the tailings would be returned underground. These tailings would be mixed with 2 to 5 percent cement and would harden into a relatively impermeable and stable mass when placed in the mined-out underground mine stopes. The hardened backfill would support the roof in mined-out areas and provide a working face and surface for mining equipment.
- Surface dry-stack and RTP This option would filter the flotation tailings to reduce the moisture content to between 12 and 15 percent. This filtered material then would be delivered by truck to a dry-stack storage site on the surface. This option would require development of a tailings pond (RTP) behind a dam to provide storage for stormwater.
  - Tailings facility liner There were two sub-options for the dry stack and RTP: a lined or unlined dry stack, and a lined or unlined RTP. Either or both facilities could be lined or unlined.
- Traditional surface wet placement In this option, flotation tailings would be pumped from the mill in a slurry pipeline to a surface impoundment where they would be deposited in a pond created by a dam. The tailings would settle out, allowing the water to be recycled.

Location Thirteen disposal sites in two general locations in the mine area were considered for the two types of surface tailings disposal (Figure 2.4-1). Seven locations were considered for traditional wet surface disposal in a tailings pond, and six locations were considered for dry surface stacking. The paste backfill disposal option would, of course, be located underground in the mine itself.

- West side of Goodpaster River Seven locations, four traditional wet disposal and three dry-stack disposal, were located west of the Goodpaster River.
- East side of Goodpaster River Six locations (three traditional wet disposal and three dry-stack disposal) were located east of the Goodpaster River.



Pogo Mine EIS

Figure 2.4–1
Tailings Disposal and
Mill/Camp Options Locations

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18 July 2002 | AMEC File:PDEIS Figure 2.4–1.dwg

A separate option indirectly related to tailings disposal location also was identified. It was a separate tunnel option under the Goodpaster River that might address concerns with surface tailings transfer to a tailings disposal site on the west side of the river.

- Off site (outside the project area) A fourteenth location, located at some unidentified point outside the project area, also was considered.

Mill and Camp Location

Six options for this component were identified (Figure 2.4-1):

- The Goodpaster River Valley floor immediately west of the ore body near the existing 1525 Portal (Site # 1)
- In the saddle on Upper Pogo Ridge southeast of the ore body (Site # 3) (There was no Site # 2.)
- On Pogo Ridge almost immediately above the ore body (Site # 4)
- On the west side of the Goodpaster River somewhat over 1 mile southwest of the ore body (Site # 5)
- In Liese Creek Valley (Site # 6)
- A generic location off site, somewhere outside the project area

Development Rock Disposal

Two options for this component were identified:

- Encapsulate mineralized development rock in the dry-stack tailings pile in upper Liese Creek Valley.
- Use nonmineralized development rock as construction material for roads, pads, and the RPT dam, as well as encapsulate some in the dry tailings stack.

Gravel Source

Two options for this component were identified:

- Expand the existing gravel pit below the 1525 Portal (Figure 2.3-1 a), develop new pits adjacent to the 3,000-ft airstrip (Figure 2.3-1 b) as well as adjacent to the access road on the west side of the Goodpaster River (Figure 2.3-1), and develop a pit at the mouth of Liese Creek Valley (Figure 2.3-1 b) and two pits adjacent to the Liese Creek tailings disposal facility (Figure 2.3-1 e).
- Gravel would not be extracted. Nonmineralized development rock that otherwise would be encapsulated in the dry tailings stack would be crushed to produce gravel.

Construction Camp Location

One option for this component was considered. A 200-person construction camp would be built at the site of the existing exploration camp below the existing 1525 Portal on the Goodpaster Valley floor (Figure 2.3-1 a). It would be used for the approximately 2 years necessary to construct a permanent camp in Liese Creek Valley. Once construction were finished, this camp would be dismantled.

Laydown Areas

Two options for this component were considered:

- Permanent laydown areas would be built on the Goodpaster Valley floor below the 1525 Portal (Figure 2.3-1 a) and adjacent to the airstrip (Figure 2.3-1 b). A smaller permanent laydown area also would be built at the mill site in Liese Creek Valley. After construction, the valley floor site below the 1525 Portal and airstrip laydown site would be reduced in size to accommodate operational phase needs.
- An expanded laydown area for operations would be built at the mill site in Liese Creek Valley, and the 1525 Portal and airstrip laydown areas on the Goodpaster Valley floor would be reclaimed after construction.

Power Supply

Two options for this component were considered:.

- Produce power on site by using diesel generators that would require an additional approximately 4.2 million gallons of fuel to be trucked to and stored at the mine site.
- Bring power to the mine site via a power line from the existing GVEA power line that parallels the Richardson Highway from Fairbanks to Delta Junction.

Water Supply

This component had two subcomponents: an industrial water source and a domestic water source.

Industrial water source Four options were considered:

- Ground water infiltrating the underground mine shaft and tunnels
- Water from the RTP in Liese Creek Valley
- Wells in the Goodpaster Valley and in upper Liese Creek Valley above the dry stack
- Water pumped directly from the Goodpaster River.

Domestic water source Two options were considered:

- Wells in the Goodpaster Valley
- Water pumped directly from the Goodpaster River.

Water Discharge

This component had two subcomponents: discharge during the mine development phase, and discharge during the operational phase.

Development phase For this phase, during which the various permanent project facilities would be constructed, three options were considered:

- Use of the same borehole/cased underground injection wells used for water discharge during the exploration phase
- Treatment and direct discharge to the Goodpaster River
- Off-river treatment works.

Operations phase For this phase, two types of discharge were addressed: industrial excess water discharge from the RTP, and domestic discharge from the mill and camp.

- Industrial wastewater (RTP) Five excess water discharge options from the RTP were considered. For all options, wastewater would be treated before discharge.
  - Discharge to an artificial wetlands constructed in an existing borrow pit below the existing 1525 Portal on the floor of the Goodpaster Valley (Figure 2.3-1 a).
  - Injection into an engineered SAS. This option had three location sub-options: near the airstrip in the Goodpaster Valley (Figure 2.3-1 b), in middle Liese Creek Valley, and in the saddle above and southeast of Pogo Ridge to be accessed by a spur road.
  - Inject water into bored/cased wells below the existing 1525 Portal, as has occurred during the exploration phase (Figure 2.3-1 a).
  - Direct discharge to the Goodpaster River (Figure 2.3-1 a).
  - Discharge through an off-river treatment works (Figure 2.4-2) that would use two ponds created in excavated gravel pits: a primary pond with an intake channel from the Goodpaster River and a separate secondary pond. Water would be pumped from the primary pond, mixed with treated process water, and discharged to the secondary treatment pond for mixing. Water from the secondary pond would be discharged via gravity flow through a screened pipe into a channel leading back to the river. Residence time in the second pond would be approximately 24 hours, which would provide ample time to respond to potential upset conditions at the water treatment plant by closing the shutoff valve in the pond's outlet works. When river ice or other restrictions limit intake flow, water would be pumped from two wells upstream of the ponds (Figure 2.4-2) to the mixing chamber (Teck-Pogo Inc., 2002i). With this option, modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. Note that the modeling conducted to determine this frequency of overtopping did not include use of supplemental groundwater from wells for dilution water in the mixing; therefore, this frequency is conservative.
- Domestic wastewater Two options were considered for domestic wastewater. Both options would use package treatment plants that would produce an effluent that would be discharged directly without further treatment.
  - Underground to a drain field. The first option had two sub-options for location of the discharge field.
    - Discharge from a Liese Creek camp and mill treatment plant to a permanent discharge field on the Goodpaster River Valley floor near the mouth of Liese Creek.

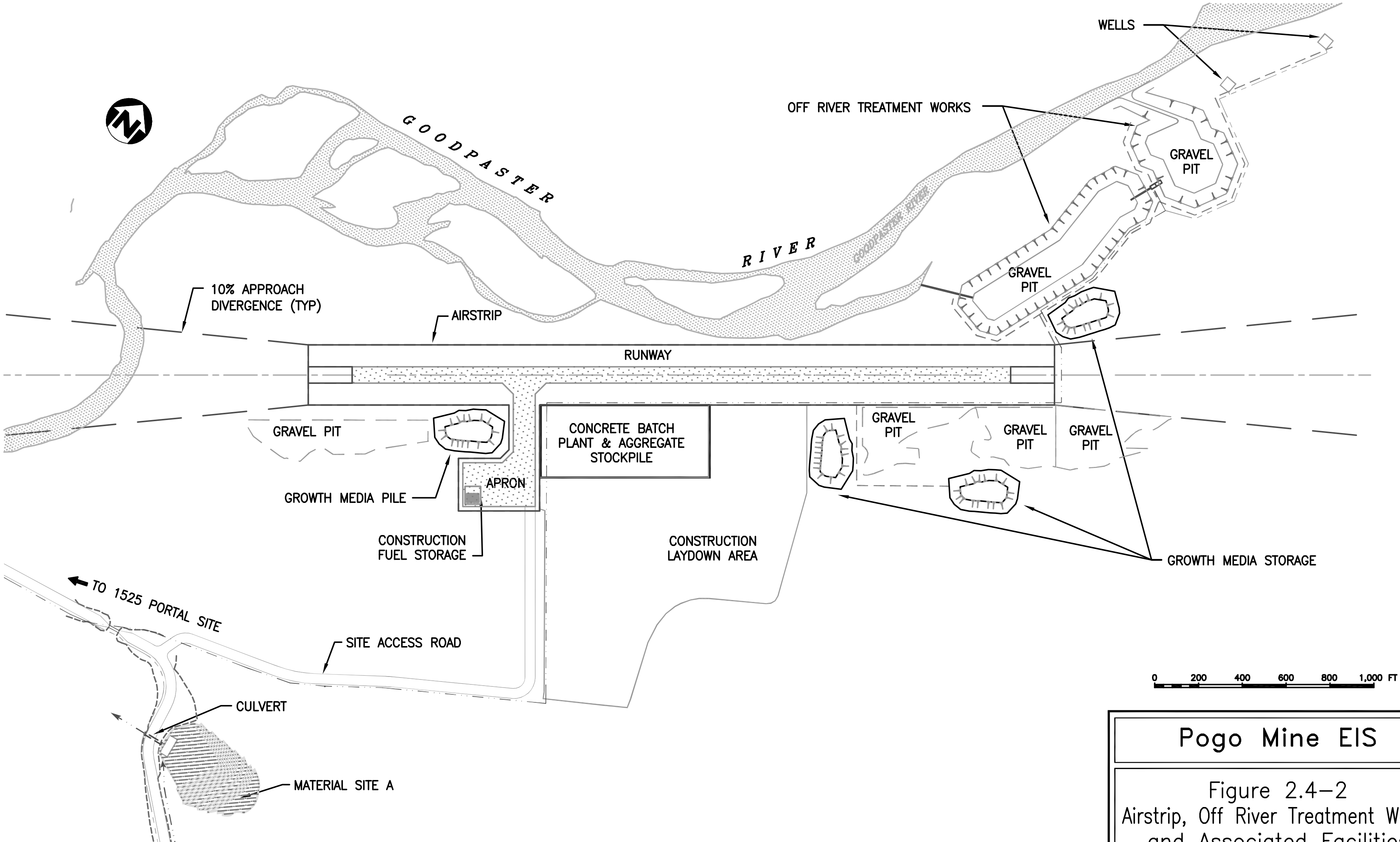

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Figure 2.4–2
Airstrip, Off River Treatment Works and Associated Facilities

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  - During the development phase, treated effluent would be discharged to a temporary discharge field on the south-facing side slope below the camp in Liese Creek Valley. Then, during operations, treated effluent would be piped through the mine to a permanent discharge field on the Goodpaster Valley floor originally built for use by the temporary construction camp during the development phase.

- Directly to the Goodpaster River. A permanent package water treatment plant would be constructed below the 1525 Portal (Figure 2.3-1 a) and would serve both the nearby temporary construction camp and the Liese Creek construction/permanent camp.

  During early operation of the construction/permanent camp in Liese Creek, sewage either would be trucked or pumped through a pipeline that would run adjacent to the site access road to the permanent treatment plant below the 1525 Portal. During operations, sewage would flow from the camp by gravity through the mine to the treatment plant. Treated effluent would be discharged directly to the Goodpaster River at a maximum rate of approximately 50 gpm during construction, and at an average rate of approximately 20 gpm during operations.

Fuel Supply and Storage

This component has two subcomponents: a fuel supply route and a storage location.

Supply route Three fuel supply route options were considered:

- An all-season road, with two route sub-options:
  - Shaw Creek Hillside route
  - South Ridge route
- Winter-only access, also with two route sub-options (which are described in more detail below under surface access routes):
  - Shaw Creek Flats route
  - Goodpaster Valley route
- An air-only supply route.

Storage location Two options for locations of diesel fuel storage were considered:

- First, construction of temporary diesel storage tanks on the Goodpaster Valley floor below the existing 1525 Portal (Figure 2.3-1 a) and adjacent to the airstrip (Figure 2.3-1 b). Smaller, permanent storage would be built at the mill in Liese Creek Valley (Figure 2.3-1 d) and at the mouth of the 1525 Portal (Figure 2.3-1 a) above the valley floor. After the construction phase, all diesel storage would be removed from the Goodpaster Valley floor.
- The second option would be the same, except there would be no permanent diesel storage at the mouth of the 1525 Portal above the valley floor. There would be a permanent 5,000-gallon Jet-A tank at the airstrip with either option.

Surface Access

This component had four subcomponents: type of access, access route, management of that access, and ultimate disposition of the access system at mine closure.

Access type This subcomponent had three options for the type of surface access: an all-season road, winter-only access, and a railroad.

- All-season road An all-season gravel road would be constructed between the Richardson Highway and the mine site. After the road was built, during intense periods of mine construction, traffic would average approximately 50 vehicles per day, roughly split between semi-tractor trailers and light vehicles. Mine-related large truck traffic would average approximately 5 to 10 per day, 7 days per week, during the day or at night. In addition, there would be an average of approximately eight other daily vehicles. Overall, mine-related vehicle use would average between 10 and 20 round trips per day. Depending on the project's particular needs, the number of trucks on a given day could be substantially higher than the average, while on other days there might be no trucks.

- Winter-only access Two winter-only access type sub-options were considered: a traditional winter road and a perennial winter trail. How these sub-options would be constructed is described later under access design.

  - Traditional winter road A traditional winter road would be constructed every year of the project's life, beginning in late November or early December. It was expected the road would be useable for approximately 8 weeks each year. Traffic would consist of approximately 30 to 35 large trucks per day, 7 days per week, day and night.

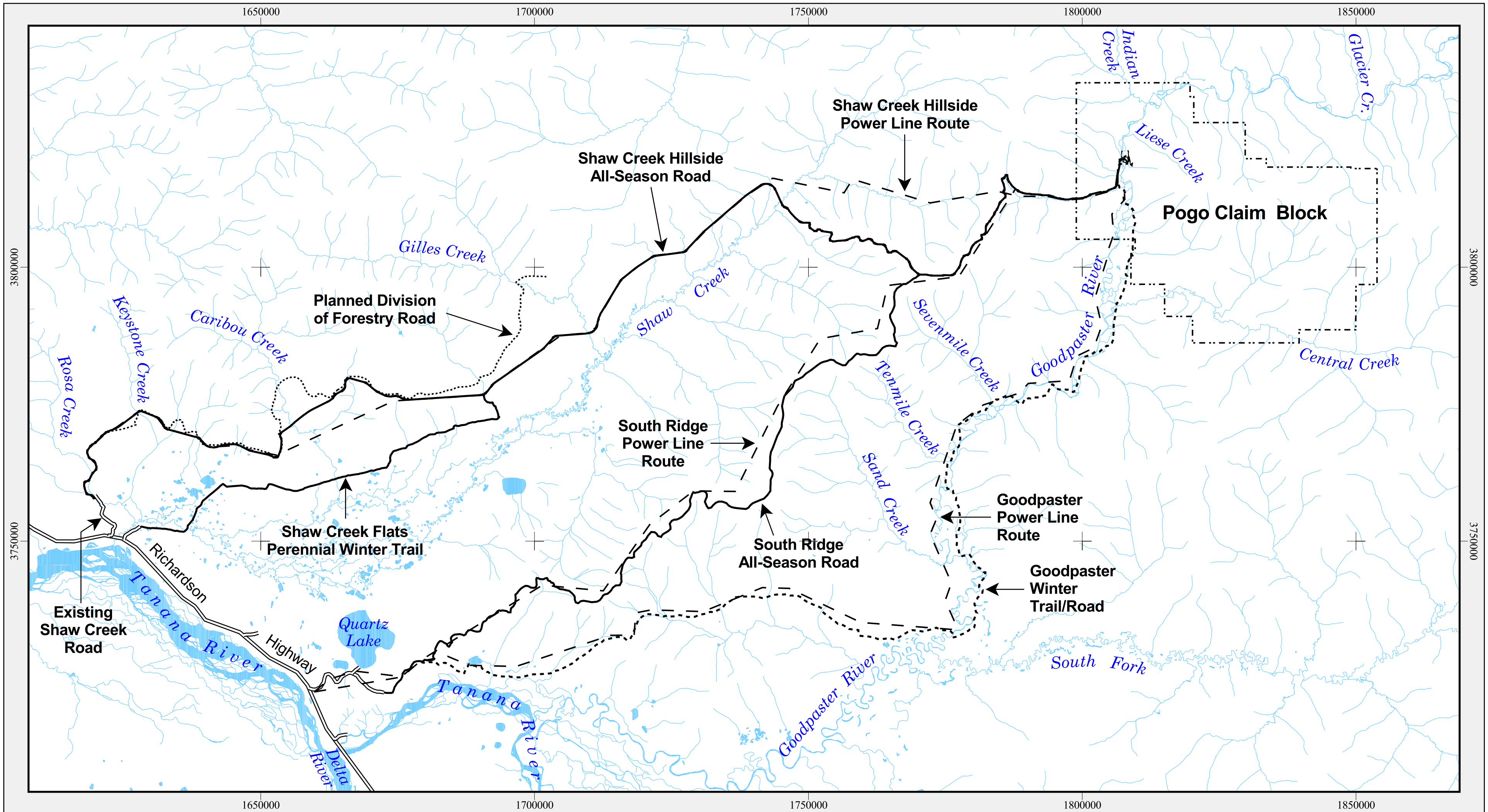
  - Perennial winter trail A perennial winter trail also would be constructed every year of the project's life, beginning in late November or early December. It was expected the trail would be useable for approximately 10 weeks each year, 2 weeks longer than would a traditional winter road. Traffic would be similar to that for the traditional winter road, but somewhat lower on a daily basis because of the longer period of operation.

- Railroad A small-gauge railroad would be built between the Richardson Highway and the mine. It would make several round trips per week carrying freight and passengers year-round.

Access route This subcomponent had three options for type of access route: those for an all-season road, those for winter-only access, and that for a railroad.

- All-season road For the all-season road option, three route sub-options were considered.

  - Shaw Creek Hillside This 49-mile route would begin at the Richardson Highway in the vicinity of Shaw Creek (Figure 2.4-3). It would proceed up the northwest side of the Shaw Creek Valley for a distance of approximately 25 miles. It then would cross Shaw Creek and climb 18 miles over the divide to the Goodpaster River and the mine site. Seven single-lane bridges would be required across six waterways: Rosa (two), Keystone, Caribou, Gilles and Shaw creeks, and the Goodpaster River.



Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

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Figure 2.4-3 Surface Access and Power Line Route Options, and Planned Forestry Road

ABR map prepared by: environmental research & services

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For the Shaw Creek Hillside route sub-option only, four sub-options were considered for the initial egress from the Richardson Highway to a point near the end of the existing 2.1-mile long Shaw Creek Road (Figure 2.4-4).

- Shaw Creek/Rosa, would use the existing Shaw Creek Road.
- Pipeline, would exit the Richardson Highway on a TAPS access road approximately one-half mile east of Shaw Creek Road. After reaching the TAPS pipeline, it would turn northwest and follow the TAPS work pad immediately adjacent to the elevated pipeline until it intersected with the Shaw Creek/Rosa sub-option route after approximately 4 miles.
- Keystone, would follow the same route to the TAPS pipeline as the Pipeline sub-option, but then would head directly north-northeast across Shaw Creek Flats until it intersected the Shaw Creek Hillside route.
- Tenderfoot, would leave the Richardson approximately 3 miles west-northwest of Shaw Creek Road (toward Fairbanks) and proceed approximately 3.5 miles over a hill until it intersected the existing Shaw Creek Road/Rosa sub-option route near the end of the existing Shaw Creek Road.

- South Ridge This 46-mile route would generally follow the ridge northwest of the Goodpaster River Valley, between that valley and Shaw Creek Valley (Figure 2.4-3). It would begin approximately 2.1 miles from the Richardson Highway at the intersection of Quartz Lake Road and the existing DOF forestry road near the public recreation area on Quartz Lake, and then travel northeast, crossing the divide between Rapid and Indian creeks. It then would climb the ridge, generally following the ridge line to the northeast, and descend to the Goodpaster Valley in the vicinity of the mine. This route would require only one bridge, across the Goodpaster at the mine site.

- Dean Cummings Crossing This approximately 64- to 70-mile route would begin approximately 28 miles east of Delta Junction where the Alaska Highway crosses the Gerstle River. The route would follow New Cummings Road northwest to the vicinity of Dean Cummings Junction where it would cross the Tanana River. From this point, the route was not well defined, but it would pass close to Healy Lake and then up the Healy River and into the Goodpaster drainage. It would require a major bridge across the Tanana, and between five and eight other bridges, depending on the route.

- Winter-only access For the winter-only access option, two route sub-options were considered: Shaw Creek Flats and the Goodpaster River Valley.

  - Shaw Creek Flats This approximately 46-mile sub-option had two sub-options, both of which would begin at the TAPS Pipeline access road off the Richardson Highway, half a mile east of Shaw Creek (Figure 2.4-3).

    - To head of Shaw Creek Valley This sub-option would follow the existing winter trail in the lower Shaw Creek Valley, and then proceed up the bottom of the upper valley for a distance of approximately 25 miles, making two crossings of Shaw Creek and three crossings of other major creeks. Because of the mountainous topography between the Goodpaster and Shaw Creek valleys, an approximately 18-mile all-season road would be constructed over the Shaw Creek and Goodpaster River divide to the mine site.

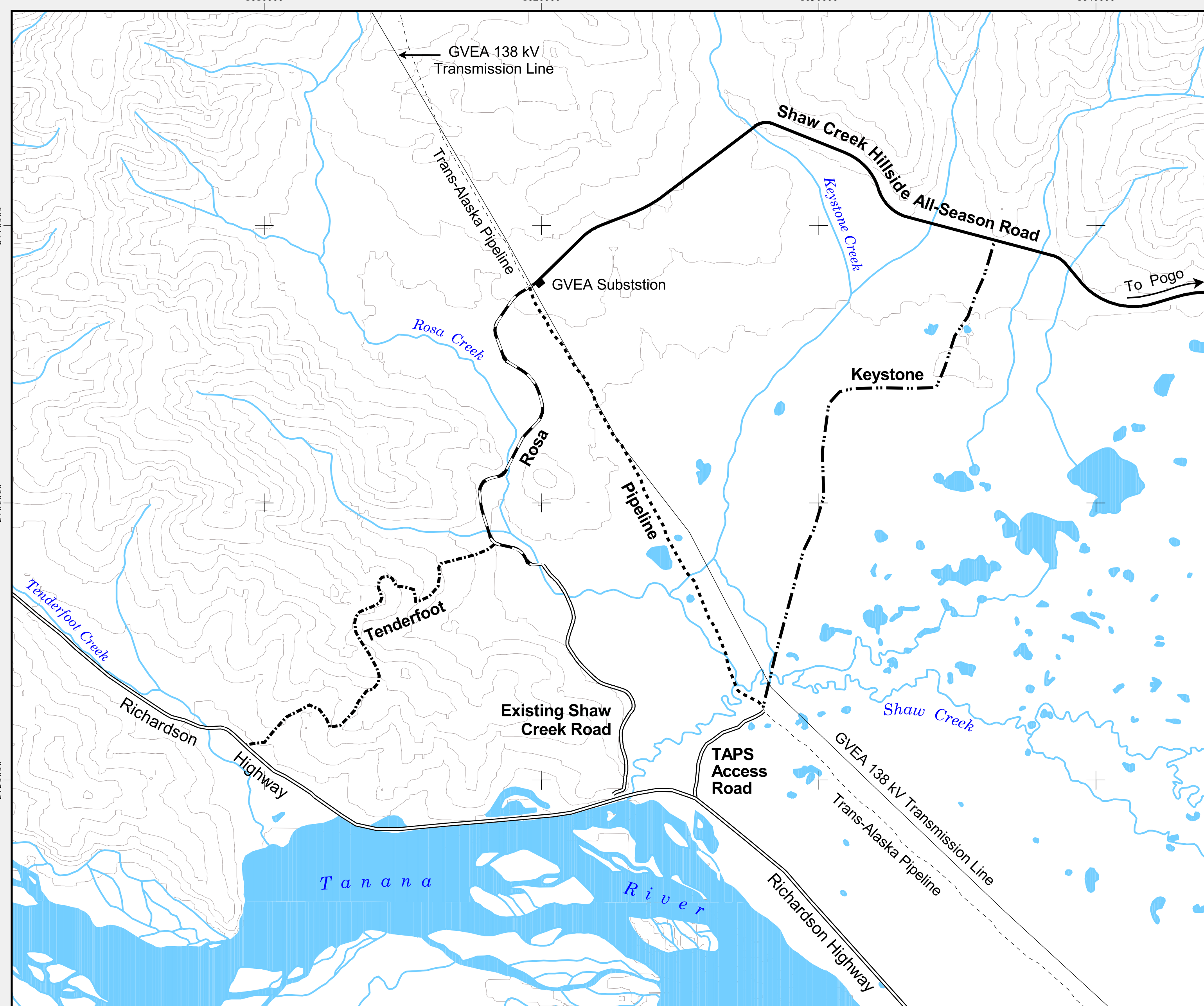

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Figure 2.4-4
Richardson Highway Egress Route Suboptions

map prepared by:
ABR INC.
environmental research & services

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- To south of Gilles Creek This shorter sub-option would follow the existing winter trail in the lower Shaw Creek Valley to a point between Caribou and Gilles creeks, and then would turn north and intersect the Shaw Creek Hillside all-season road route, a distance of approximately 15 miles. It then would follow the all-season route approximately 30.5 miles to the mine site.

- Goodpaster River Valley This 49-mile route would follow the existing winter trail up the Goodpaster Valley (Figure 2.4-3). Like the South Ridge all-season route, it would begin at the intersection of Quartz Lake Road and the existing DOF road near the public recreation area on Quartz Lake. It would require nine crossings of the Goodpaster River and several other minor crossings. The Applicant used this road during the winter of 1997-1998 to haul in equipment, supplies, and fuel for its exploration program.

- Railroad Railroads by their nature have severe grade limitations. Therefore, for this option, the Goodpaster River Valley would be the only practicable route. The route logically would follow closely the existing winter trail, beginning at the intersection of Quartz Lake Road and the existing DOF road near the public recreation area on Quartz Lake. It would require approximately six to nine crossings of the Goodpaster River and several other minor crossings.

Access management This subcomponent had thee types of access management: that for design of the access system, that for managing actual use of the access system, and that for location of a security gate for an all-season road.

- Access design Two design issues were considered: that for an all-season road and that for winter-only access.
  - Two all-season road designs were considered.
    - One-lane road The road surface would be approximately 15 ft wide with approximately three additional 15-ft-wide by 300-ft-long turnouts per mile to allow traffic to pass. It would have single lane bridges and a maximum grade of 10 percent, and would be designed for a speed of 35 miles per hour.
    - Two-lane road The road surface would be 24 ft wide, with single-lane bridges and a maximum grade of 10 percent, and would be designed for a speed of 35 miles per hour. There would be no turnouts.
  - Two winter-only access designs were considered.
    - Traditional winter road The road surface would be composed of snow and ice built on top of the organic layer. Construction would involve grooming the snow to promote freeze-up of the trail, hauling snow and water and icing the trail surface where necessary, installing temporary bridge structures at select stream and river crossings, and constructing ice bridges and snow and ice ramps. There would be little clipping of tussocks or blading into the mineral soil.
    - Perennial winter trail This option would be similar to the traditional winter road, except the trail surface would be bladed flat and would require small cuts and fills and limited removal of some surface organics, including clipping off tussocks. This flatter micro-topography would allow a drivable snow and ice surface to be constructed more quickly each winter, thus providing a longer winter operating window than a traditional winter road.

- Access use Three road or trail use options were considered during the life of the Pogo project. The first would allow use for Pogo project-related purposes only. Second would be for Pogo project-related purposes as well as for other industrial/commercial users. The third option would allow road use by everyone.

- Security gate location Two locations for a security gate for the Shaw Creek Hillside all-season road route option were considered: near the end of the existing Shaw Creek Road and at Gilles Creek approximately 23 miles up the Shaw Creek Valley from the end of the existing Shaw Creek Road.

Access disposition This subcomponent had three options for access system disposition after mine closure:

- Remove and reclaim the road at the end of the Pogo project

- Convert the road to a recreational hiking trail

- Leave the road in place

  If an all-season road were to be left in place, two sub-options for its continued use were considered:

  - Restrict use to industrial and commercial resource users

  - Leave the road open for use by everyone

Air Access

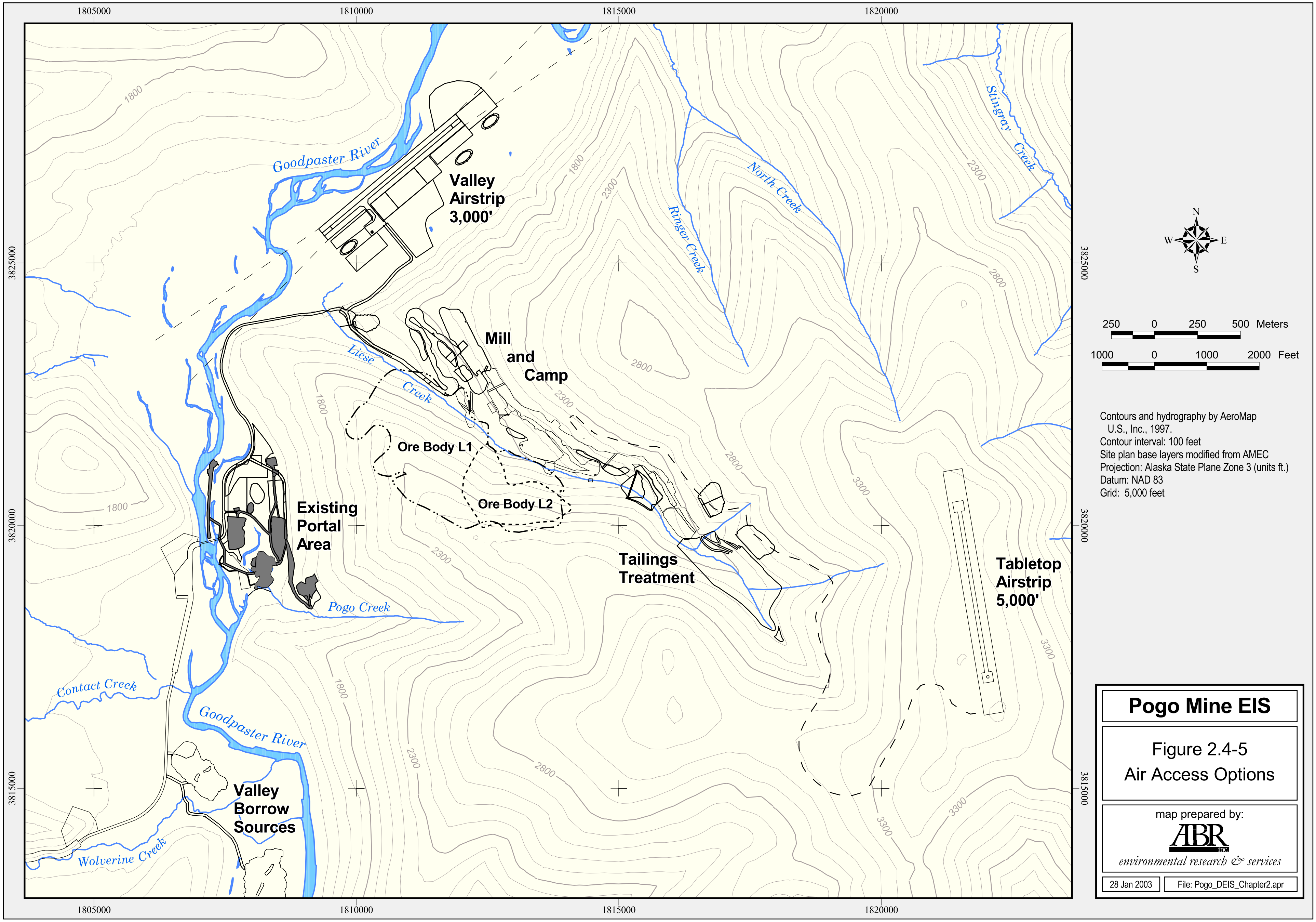
This component had three subcomponents: type of air access, management of that access, and ultimate disposition of the access system at mine closure.

Access type This subcomponent had three options: an air-only access option, air access as a complement to surface access, and no air access complement to surface access.

- Air-only access Under this option, almost all movement of personnel and supplies would be by air, with no all-season road or regular annual winter-only access. A winter road still would have to be constructed up the Goodpaster Winter Trail for the first two or three consecutive seasons in order to mobilize and demobilize the equipment and supplies necessary to construct an airstrip and the other mine facilities, and to supply the initial inventory. Winter-only access, however, still would have to be used periodically for items too large to be transported by air.

- Complement to surface access Two complementary air sub-options for surface access were considered (Figure 2.4-5).

  - 3,000-ft airstrip This airstrip would be located in the Goodpaster Valley just north of the mouth of Liese Creek in conjunction with the all-season road option. This strip would be capable of handling SkyVan, Caribou, DC3, CASA 212, Caravan, and King Air aircraft. Approximately two flights per week would be required to transport supplies and personnel during mine operations.



Pogo Mine EIS

Figure 2.4-5
Air Access Options

  - 5,000-ft airstrip This airstrip would be located at the Tabletop site above and east of Liese Creek Valley in conjunction with the winter-only access option. This strip would be capable of handling large DC-6 and Hercules C-130 aircraft. Approximately 500 flights per year would be required to transport supplies and personnel during mine operations.

- No air complement to surface access There would be no air access to the mine site, only surface access.

Access management This subcomponent had three options for managing air access use during the life of the Pogo project:

- Pogo project-related purposes only
- Pogo project-related purposes as well as for other industrial and commercial resource purposes
- Open to use by everyone

Access disposition This subcomponent had two options for airstrip disposition after mine closure and reclamation:

- Remove and reclaim the airstrip
- Leave the airstrip in place

  If the airstrip were to be left in place, two sub-options for its continued use were considered:

  - Restrict use to industrial and commercial resource users
  - Leave the airstrip open for use by everyone

Power Line Route

Three route options were considered for this component, each relatively closely paralleling a surface access route option (Figure 2.4-3):

- All-season road:
  - Shaw Creek Hillside
  - South Ridge
- Winter-only access:
  - Shaw Creek Hillside
  - Goodpaster River Valley

Note that for the Shaw Creek Flats winter-only surface access option, the power line in the lower Shaw Creek drainage would follow the power line route for the Shaw Creek Hillside all-season road option and would not be located in the flats near the winter road or perennial winter trail in the valley bottom. These routes are described in more detail above under ground access routes.

2.4.3 Options Screening Process

Once all the options that addressed the scoping issues had been identified in Section 2.4.2, it was necessary to screen them to reduce the more than 100 options and sub-options initially identified to a more manageable number that still provided a reasonable range from which to identify full project alternatives.

This process was conducted by the third-Party EIS team and agency representatives. First, it involved developing objective evaluation criteria for each scoping issue. Then, each option was screened against those criteria to determine which options best addressed the scoping issues. These options then were retained for detailed impacts analysis in Chapter 4, and the other options were dropped from further consideration. This process was comprehensive and time consuming, and readers are referred to Appendix A.1 in which each step in the process is described.

Following the options screening process, the remaining options and sub-options were grouped to form alternatives to the Applicant's proposed project. How this was done is described next in Section 2.5 (Action Alternatives Identification).

2.5 Action Alternatives Identification

Alternatives Construction

An action alternative contains an option for each project component so that if the alternative were constructed it would produce a functioning project. How options are assigned to a particular alternative, however, depends on such factors as the nature of the project, the issues identified during scoping, and expected impacts. Because of the large number of Pogo project components, options, and sub-options, the number of permutations and combinations was very high. Without careful alternative construction, a substantial number of confusing alternatives could have resulted. Therefore, it was important to assign options to alternatives in a way that would reduce the number of action alternatives to the minimum necessary to provide a structure that could accurately describe and compare environmental impacts in Chapter 4 in an understandable manner.

To best accomplish the description and comparison of environmental impacts, in a few instances the action alternatives in this EIS present more than one option or sub-option for a particular component. Doing so eliminated the need to identify an entirely new alternative that would differ for only that single component. An example is the Richardson Highway egress sub-option. The two route choices for this sub-option that were carried forward for detailed analysis in Chapter 4, the existing Shaw Creek Road/Rosa route and the Tenderfoot route, were both assigned to Alternative 2 for impact analysis because they were specific only to the Shaw Creek Hillside all-season road route, which is found only in Alternative 2. Although Alternative 2 is the Applicant's Proposed Project, and the Applicant did not propose the Tenderfoot route, the discussion of Alternative 2 was the logical place to discuss and compare its impacts with the Shaw Creek Road/Rosa route, and doing so eliminated the need to identify an entirely new alternative that would differ only in this small route segment specific to only one alternative.

Another example concerned the fuel storage subcomponent related to the on-site power generation option. With on-site power generation, additional diesel fuel storage at the mine site would be needed. If surface access were provided by an all-season road, only an additional 1.6 acres of fuel storage would be needed. If surface access were provided by winter only access, however, an additional 6.1 acres of fuel storage would be needed (because fuel would have to be stored for an entire year). Thus, to allow these two options to be compared without identifying an entirely new alternative, they are discussed where applicable under existing alternatives.

Section 2.2 above described Alternative 1, the No Action Alternative. Alternative 1 considers what would happen in the project area if no action were taken and the Pogo Mine project did not go forward. All other alternatives addressed in this EIS are called “action alternatives.”

An **action alternative** is one that if the agencies took the actions to implement it by issuing the necessary permits, a change would occur in the project area from the situation described in the No Action Alternative.

The first action alternative is Alternative 2, the Applicant's Proposed Project. This alternative was described in detail in Section 2.3 to provide an understanding of what the Applicant's proposed Project would entail. NEPA, however, requires that an EIS consider feasible alternatives to the Applicant's Proposed Project that address issues raised during the scoping process. The previous section, 1.1, described how the scoping issues were identified, how options and sub-options were developed to address those issues, and how those options and sub-options were screened to determine which ones best addressed the scoping issues, and which should be dropped from further consideration. This section, 2.5, describes how the remaining options and sub-options were grouped to form two additional action alternatives; that is, alternatives to the Applicant's Proposed Project (Alternative 2).

To present these options and sub-options as part of the three action alternatives in the most understandable manner, they have been divided into the following three groups of components, which are described and presented in tabular format in the following subsections.

1. Options and sub-options that are common to all three action alternatives
2. Options and sub-options that vary among the alternatives, but that are not related to surface access
3. Options and sub-options that vary among the alternatives, and that are related to surface access

2.5.1 Options Common to All Action Alternatives

The first component group consists of 11 project components, with 23 options, that are common to all three action alternatives (Table 2.5-1). That is, these options would be the same regardless of the alternative ultimately selected. Because they are common to all action alternatives, their impacts are discussed separately as a group in Chapter 4 (Environmental Consequences).

Table 2.5-1 Component Options and Sub-Options Common to All Action Alternatives

Milling Process
- Gravity/flotation/cyanide vat leach[1]

Tailings Disposal
- Underground paste backfill
- Surface dry stack and RTP in Liese Creek Valley

Mill and Camp Location
- Liese Creek Valley

Development Rock Disposal
- Mineralized rock encapsulated in dry stack
- Nonmineralized rock in dry stack, for RTP dam, and for other construction

Gravel Source
- Expand existing pits; develop new pits in Goodpaster and Liese Creek valleys
- Crush nonmineralized development rock

Construction Camp
- At existing exploration camp below 1525 Portal in Goodpaster Valley

Laydown Area
- Permanent below existing 1525 Portal, adjacent to airstrip, and at mill

Water Supply

Industrial
- Mine drainage
- RTP
- Wells

Domestic
- Wells

Water Discharge

Operations Phase
- Domestic wastewater
  - ✦ Package treatment plant and direct discharge to Goodpaster River

Fuel Storage Location
- Temporary below 1525 Portal and airstrip; permanent at portal mouth and mill

Air Access
- 3,000-ft airstrip in Goodpaster Valley

Use
- Pogo project only
- Pogo and other industrial/commercial users only
- Everyone

Disposition
- Remove and reclaim following mine reclamation
- Open for Industrial/commercial resource users only
- Open for everyone

[1] Underline – Applicant's proposed option or sub-option

2.5.2 Nonsurface Access-Related Options Specific to Action Alternatives

The second group consists of 3 project components, with 13 options and 2 sub-options that are specific to certain action alternatives, but that are not related to the issue of surface access (Table 2.5-2). An "X" indicates that a particular option or sub-option is contained in a given alternative. Because they are all unrelated to surface access issues, their impacts are discussed separately as a group for each resource in Chapter 4.

Because these options and sub-options were independent of the type and route of surface access, they were assigned to an action alternative in a manner that best allowed for a comparison between related options and sub-options.

Table 2.5-2 Component Options and Sub-Options that are Specific to Certain Action Alternatives, but Not Related to Surface Access

Component/Option/Sub-option	Alternative 2	Alternative 3	Alternative 4
Tailings Facility Liner			
▶ Surface dry stack and RTP in Liese Creek[1]			
✦ Lined dry stack		X	X
✦ Lined RTP		X	X
✦ Unlined dry stack	X		
✦ Unlined RTP	X		
Power Supply			
▶ Power line	X	X	
▶ On-site generation			X
Water Discharge			
Development Phase			
▶ Underground injection wells	X		
▶ Direct discharge to Goodpaster River		X	
▶ Off-river treatment works			X
Operations Phase			
▶ Soil absorption system (SAS)	X		
✦ Goodpaster River Valley adjacent to airstrip	X		
✦ Saddle above and southeast of Pogo Ridge	X		
▶ Underground injection wells	X		
▶ Direct discharge to Goodpaster River		X	
▶ Off-river treatment works			X

[1] Underline – Applicant's proposed option or sub-option

2.5.3 Surface Access Related Options Specific to Action Alternatives

The third group consists of 2 project components, with 10 options and 8 sub-options, that vary among action alternatives, and that are directly related to surface access (Table 2.5-3). An "X" indicates that a particular option or sub-option is contained in a given alternative. Because they are all directly related to the surface access issue, their impacts are discussed separately as a group for each resource in Chapter 4.

The biggest difference between the three action alternatives in this group concerned surface access to the mine site, both by type and route. Alternative 2 (Applicant's Proposed Project) contains the Shaw Creek Hillside all-season road option; Alternative 3 contains the South Ridge all-season road option; and Alternative 4 contains the Shaw Creek Flats winter-only access option.

The primary thrust of Alternative 3 was to define an alternative that offered an all-season road option other than the Applicant's proposed Shaw Creek Hillside all-season route. The primary purpose of Alternative 4 was to define a surface access option specifically designed to avoid all-season access so that there would be a physical barrier to public access rather than only a management decision about whether public use would be permitted.

The allocation of some options and sub-options to specific alternatives depended on the particular surface access option. For example, whether the initial all-season road egress from the Richardson Highway would be via the existing Shaw Creek Road or the Tenderfoot route was specific only to the Shaw Creek Hillside route; therefore, both were assigned to Alternative 2. In a similar manner, the two power line route options were specific to the surface access route they would parallel; therefore, each was assigned to the alternative containing its corresponding access route. Also, how use of an all-season road would be managed, and whether it would be removed at the end of the Pogo project, were applicable only to the all-season road options in Alternatives 2 and 3, and not to the winter-only access option.

Figure 2.5-1 graphically presents all the options that differ among the action alternatives (Tables 2.5-2 and 2.5-3). Those on the left side of the figure are not related to surface access, and those on the right side of the figure are related to surface access. Note that Figure 2.5-1 does not contain those options that would be common to all alternatives (Table 2.5-1) because, by definition, there would be no difference in impacts among the alternatives.

Table 2.5-3 Component Options and Sub-Options that are Related to Surface Access

Component/Option/Sub-option	Alternative		
	2	3	4
Surface Access			
Route			
▶ Shaw Creek Hillside all-season road[1]	X		
✦ Shaw Creek Road/Rosa egress from Richardson Highway	X		
✦ New Tenderfoot egress from Richardson Highway	X		
▶ South Ridge all-season road		X	
▶ Shaw Creek Flats winter-only access			X
✦ Traditional winter road construction standards			X
✦ Perennial winter trail construction standards			X
Use			
▶ Pogo project only	X	X	
▶ Pogo and other industrial/commercial users only	X	X	
▶ Everyone	X	X	
✦ Security gate near end of Shaw Creek Road	X		
✦ Security gate at Gilles Creek	X		
Disposition			
▶ Remove and reclaim	X	X	
▶ Leave road open (versus closed) to:			
✦ Industrial/commercial users	X	X	
✦ Everyone	X	X	
Power Line Route			
▶ Shaw Creek Hillside	X		
▶ South Ridge		X	

[1] Underline – Applicant's proposed option or sub-option

ALTERNATIVES ANALYZED IN THIS EIS

AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1] =	COMPONENTS NOT SURFACE ACCESS RELATED				+ COMPONENTS SURFACE ACCESS RELATED				
			WATER DISCHARGE		ACCESS				
	TAILINGS FACILITY LINER +	POWER SUPPLY +	DEVELOPMENT PHASE +	OPERATIONS PHASE +	TYPE +	ROUTE +	USE +	DISPOSITION +	POWER LINE ROUTE
	Options	Options	Options	Options	Options	Options	Options	Options	Options
ALTERNATIVE 1 **NO ACTION**	Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented.								
ALTERNATIVE 2 Applicant's Proposed Project	Unlined	Power Line	Injection Wells	▪ Injection Wells, and ▪ SAS ◆ At airstrip ◆ Above Pogo Ridge	All-Season Road	▪ Shaw Creek Hillside, Richardson Egress ◆ Shaw Creek Road ◆ Tenderfoot	▪ Pogo Project Only, or ▪ Pogo and: ◆ Industrial/ Commercial ◆ Everyone	▪ Remove/Reclaim, or ▪ Road Left Open to: ◆ Industrial/ Commercial ◆ Everyone	Shaw Creek Hillside
ALTERNATIVE 3 South Ridge Route Direct Discharge	Lined	"	Direct Discharge to Goodpaster River	Direct Discharge to Goodpaster River	"	South Ridge	"	"	South Ridge
ALTERNATIVE 4 Winter Only Access Off-River Treatment Works	"	On-Site Generation	Off-River Treatment Works	Off-River Treatment Works	Winter Access Only ▪ Traditional Road ▪ Perennial Trail	Shaw Creek Flats	N/A[2]	N/A	N/A
Major Options Eliminated From Further Consideration[3]			Constructed Wetlands		Railroad; Air Only (5,000-ft Airstrip)	Richardson Egress: ▪ Pipeline ▪ Keystone; Dean Cummings Crossing; Goodpaster Valley		Convert to Recreational Trail	

[1] Excludes those components/options common to all alternatives (Table 2.5-1).
[2] Not applicable to this alternative.
[3] See Appendix A.1.

Figure 2.5-1

Chapter 3 Affected Environment

To determine whether a project alternative would have a significant effect on the human environment, an accurate understanding of the proposed project's environment is necessary as it exists *before* project development. This chapter describes, on a resource-by-resource basis, the existing environment that could be affected if the project were to proceed. This description provides a baseline against which project development impacts may be measured.

Much of the baseline information in this chapter has been taken from the Pogo project environmental baseline document (Teck-Pogo Inc., 2000f). Individual resource baseline reports from this document may be found at pogomineeis.com under "Baseline Documents."

3.1 Geology

3.1.1 Regional Geology

The project area is in the Yukon Crystalline Terrain (Weber *et al*., 1978). The predominate rock unit mapped is gneiss, probably Paleozoic in age. Granodiorite to quartz monzanite have been identified on the fringes of the Pogo Mine site. These granitic units are believed to be undifferentiated Tertiary and Cretaceous rocks. Gneiss, biotite gneiss, and quartzite are indicated in the vicinity of major tributaries of the Goodpaster River (West Creek, Central Creek, and Sonora Creek).

3.1.2 Local Geology

Gold mineralization in the Liese Creek area is hosted in a package of highly deformed, Precambrian to Paleozoic, amphibolite-grade paragneiss and lesser orthogneiss of the Yukon-Tanana terrain, a belt of rocks which stretches over 600 miles in Alaska and the Yukon. The gneisses are intruded by unaltered to quartz-sericite and altered Cretaceous granitoid rocks. The Cretaceous intrusive rocks are regionally extensive and previously assumed to be related to intrusions and mineralization in the Fairbanks gold camp (e.g., Fort Knox Mine) and elsewhere in the Yukon. Recent geochronological work is beginning to cast some doubt on this interpretation, suggesting that the rocks may be distinctly older.

The Liese Creek area is predominantly underlain by gneisses. To the north, the gneiss is intruded by the Goodpaster batholith, a large granitoid body of mid-Cretaceous age. Gneisses in Liese Creek are intruded by numerous granitoid dikes, presumably related to the Goodpaster batholith. Gold mineralization in the Liese Zone is in part hosted by large quartz vein/replacement bodies, which may be roughly parallel to and contemporaneous with the granitoid dikes. Zones of low-grade, quartz stockwork-hosted gold mineralization are also present. The youngest geologic unit in the area is a diorite dike in Liese Creek, which appears to be northwest-trending and steeply dipping, and to post-date and partly cut off mineralization on the northeast edge of the deposit.

3.2 Physiography

The Pogo Mine site is located in the Yukon-Tanana Uplands Physiographic Province (Wahrhaftig, 1965) of interior Alaska. The Goodpaster River flows south past the site and meanders within a confined alluvial valley with tributaries that drain the surrounding uplands. The tributaries have steep upper gradients and gentle lower gradients as they descend from an elevation of approximately 2,500 feet to the valley bottom. The area is regionally nonglaciated, leaving V-shaped valleys with steep side slopes, particularly in their upper reaches. On the uplands, coarse gravelly soils derived from the bedrock are common. Organic soils occur in tussock meadows associated with drainages.

Shaw Creek Valley is noticeably wider than the Goodpaster Valley, with its mouth at the Richardson Highway being approximately 8 miles wide. Shaw Creek Flats is a continuously frozen terrace of the Tanana River (Kreig and Reger, 1982). The surface is underlain by organic silts, silty sand, and gravelly alluvium. The northwest side of the Shaw Creek Valley is composed predominately of vegetated sand dunes.

3.3 Permafrost and Soils

Permafrost, or perennially frozen ground, is encountered throughout the project area, especially at lower elevations. Major engineering problems can arise where warming and melting of the permafrost occurs in fine-grained soils. Fine-grained permafrost soils may contain large amounts of interstitial or segregated ice. As the permafrost melts, the resulting volume reduction of the soil mass can cause subsidence (thaw settlement). Additionally, the excess moisture content in thawing fine-grained soils may cause instability on slopes and the downslope movement of the thawing soil mass.

Permafrost soils are classified on the basis of their tendency to undergo volumetric changes upon thawing. Thaw-stable permafrost soils are those that do not undergo significant volumetric changes and, as a result, do produce only minor engineering impacts upon thawing. Thaw-stable soils are typically sands and gravels containing minor amounts of fine soils such as silts.

Thaw-unstable permafrost soils do undergo significant volumetric changes and can create major engineering problems upon thawing. Fine-grained soils such as ice-rich silts and clays and silty sands are examples of thaw-unstable soils.

The Pogo Mine site is within the discontinuous permafrost region of central Alaska, and the occurrence of permafrost is widespread, especially at lower elevations. Thermistor cables installed at prospective tailings sites 1 and 4B indicate that permafrost temperatures are in the range of 29°F to 31°F. The relatively warm permafrost temperatures in central Alaska make the permafrost thermal regime thermally sensitive, and degradation can occur if the surface is cleared or disturbed. The presence or absence of permafrost in the Pogo area is highly dependent on topographically controlled microclimate, drainage, slope aspect, snow accumulation patterns, surface vegetation, and soils. Permafrost represents a significant engineering problem in the design of diversion ditches and the design of dams and impoundment reservoirs, especially those with a high hydraulic head. Permafrost in the Pogo area may be either thaw-stable or thaw-unstable, depending on the ice content of site-specific soil conditions.

3.4 Geotechnical and Seismic Considerations

Geomorphic processes, including erosion, mass wasting, and deposition, have resulted in a range of unconsolidated surficial soils overlying bedrock. The surficial soils in the Pogo area can be described as two predominate units: alluvium and colluvium. Alluvium is stratified riverbed deposits of sand, gravel, and cobbles that may have an overlying layer of fine-grained floodplain overbank deposits. In some valleys, in-filled channels and cutoff meanders contain organic silt and peat, commonly in a permafrost condition.

The colluvium is commonly a heterogeneous mixture of silt, sand, and gravel and cobble-sized angular rock fragments formed by the weathering products of the local bedrock that have been transported downslope by gravity. Fine-grained colluvium can occur on lower slopes as veneer or valley fillings along the base of slopes where eolian silt originally deposited on hilltops and hillsides has been re-transported downslope. These fine-grained colluvial deposits are commonly found at lower elevations in a permafrost condition and may contain considerable interstitial and segregated ice.

Three active faults that could affect the design of Pogo facilities are present in central Alaska. Specifically these are the Donnelly Dome, Denali, and McGinnis Glacier faults located to the south of the project area in the Alaska Range. These three faults are well identified and have surface expressions and evidence of significant movement in the last 10,000 years. Additionally, the Salcha Seismic zone located west of the project (oriented parallel to the Salcha River Valley) is considered to be active, although no surface expression of a fault has been discovered.

The estimated peak ground acceleration for the Pogo Mine site with a 2 percent probability of exceedance in 50 years is 0.21g (21 percent of gravity) (USGS, 2001).

3.5 Surface Water Hydrology

The Pogo project is located within the Goodpaster River basin, a tributary of the Tanana River, a tributary of the Yukon River (Figure 1.3-1). There are ten main surface water drainages within the Pogo claim block in the mine vicinity, excluding the Goodpaster River: North Creek, Liese Creek, Pogo Creek, Easy Creek, Star Creek, West Creek, Central Creek, Sonora Creek, Wolverine Creek, and Contact Creek (Figure 1.3-3). All are directly tributary to the Goodpaster River, except Sonora Creek, which is tributary to Central Creek. Principal surface water features associated with the mine area access corridors include Shaw Creek and its major tributaries, referred to as Gilles Creek and Caribou Creek (Figure 2.4-3). The access corridors also have a number of smaller crossings, including Rosa and Keystone in the Shaw Creek drainage and Wolverine Creek in the Goodpaster River drainage.

Surface water in the vicinity of the project is essentially undeveloped and pristine. Man-made structures modifying the flow regime or flow characteristics are nonexistent. Currently, local use for municipal water supply, irrigation, or industrial application is also nonexistent. Some incidental use of the Goodpaster River water as water supply to cabins located in the lower reaches is documented. All proposed project facilities, except the power line and access road corridors, would be located within the Liese Creek drainage basin and Pogo Creek drainage, and adjacent to the Goodpaster River itself. The access corridors are within the Shaw Creek drainage or on the ridge between Shaw Creek and the Goodpaster River. The following discussions focus principally on Shaw Creek, Goodpaster River, and Liese Creek because these are most subject to potential impacts.

3.5.1 Drainage Basin Physiography and Topography

Generally, the streams within the project area are typical for the east-central region of interior Alaska. The area in and around the proposed project area is composed of mountainous, nonglaciated terrain dissected by numerous deep, steeply sloping ravines/valleys and flattened/plateau uplands between drainages. These valleys contain ephemeral and intermittent stream channels that are typically high gradient streams near their source, often flattening to diffuse flows within willow/muskeg before their confluence with larger waterways. The regional terrain varies in elevation from 1,200 ft to 5,000 ft above mean sea level (AMSL) for a total relief of approximately 3,800 ft (Beckstead, 2000). The region in and around the project area has permafrost zones; however, permafrost is typically not located beneath or immediately adjacent to streams and rivers. Table 3.5-1 presents a summary of the project area streams and the physiographic characteristics of drainage areas. Drainage basin physiography and topography Drainage basin physiography and topography.

Table 3.5-1 Pogo Mine Project Area Drainage Physiography

	Stream Name	Drainage Area (sq mi)	Channel Length (mile)	Basin Relief (ft)	Flow Regime
Mine Area					
	Goodpaster River	1,502	131	2,700	Perennial
	North Creek	1.5	2.1	2,100	Intermittent
	Liese Creek	2.2	2.2	1,600	Intermittent
	Pogo Creek	1.1	0.8	1,800	Intermittent
	Easy Creek	1.4	0.5	2,100	Intermittent
	Star Creek	1.8	1.9	2,200	Intermittent
	West Creek	6.5	4.9	2,200	Perennial
	Central Creek	116	23	3,200	Perennial
	Sonora Creek	11.0	6.0	2,200	Perennial
	Wolverine Creek	1.7	6.2	1,900	Perennial
	Contact Creek	6.0	4.0	2,600	Perennial
Access Corridor					
	Shaw Creek	392	40.8	3,200	Perennial
	Rosa Creek	15.5	8.0	1,900	Perennial
	Keystone Creek	11.8	9.1	1,200	Perennial
	Caribou Creek	24.8	8.0	1,800	Perennial
	Gilles Creek	42.0	15.2	2,300	Perennial

The dominant stream, the Goodpaster River, is a meandering fluvial system in some reaches. As it approaches the confluence with the Tanana River, it becomes multi-channeled and highly meandering, with a slow-flowing and generally shallow main channel. Both the Goodpaster River and Shaw Creek lie in relatively broad valleys with floodplain terraces. More detailed descriptions of Liese Creek, Shaw Creek, and the Goodpaster River are provided below.

Liese Creek

Liese Creek is a small intermittent stream that drains the north side of the ridge containing the primary mineralized zone that would be mined. It flows above a portion of the ore body to be mined. The Liese Creek basin encompasses approximately 1,502 acres (Teck-Pogo Inc., 2002b) and ranges in elevation from 1,400 ft to 3,600 ft, for a total basin relief of approximately 2,200 ft. The channel length within this basin is approximately 2.2 miles. The basin is essentially rectangular in shape. The channel of Liese Creek lies on valley fill alluvium/colluvium consisting of gravel, cobble, and boulders in a matrix of fine to very fine sands. A high gradient, cascades, and few meanders characterize the Liese Creek channel morphology, with boulders and cobbles substrate in the upper reaches. The active channel width varies from 3 ft to 10 ft with a depth of approximately 2 ft (Teck-Pogo Inc., 2002b). In the lower reaches, the stream enters an alluvial fan area and the gradient flattens, pools form, and the channel becomes diffuse to nonexistent as it enters a large wetland near the Goodpaster River (Morsell, 2000). In this area, the alluvial fan of Liese Creek is nearly indistinct from the alluvial floodplain of the Goodpaster River.

Goodpaster River

The Goodpaster River is a major tributary of the Tanana River. The river is nonglacial in origin and possesses the channel morphology, sedimentology, and flow regime of a nonglacial river. The flow regime of the Goodpaster River is perennial. This river has a total drainage area of approximately 1,502 square miles (sq mi) (961,318 acres), of which approximately 677 sq mi (433,280 acres) are above the proposed mine site. The drainage basin ranges in elevation from 1,000 ft to 6,500 ft with a total basin relief of approximately 5,500 ft. The river channel lies on deep valley fill of alluvium consisting of sand, gravel, and cobbles. The lower reaches of this river are relatively shallow and slow due to the low gradient. The mid-reaches, near the proposed mine site, and the upper reaches are moderate in gradient, resulting in alternating mild rapids/riffles and pools. The river channel is contained within a broader valley that appears to function as a floodplain. The Goodpaster River, however, has a well-established channel with vegetated banks and a relatively stable, cobble- and gravel-armored channel bottom in its mid-reaches near the proposed mine site.

Shaw Creek

Shaw Creek is a medium-size perennial stream and a direct tributary of the Tanana River. Its confluence is approximately 7 miles downstream of the confluence of the Delta and Tanana rivers. The headwaters of Shaw Creek are located approximately 5 miles west of the Pogo claim block and are separated from the Goodpaster River drainage by a substantial ridge of mountains. Shaw Creek flows from northeast to southwest down a relatively straight, elongate valley bounded by mountains on both sides. Shaw Creek has multiple major tributaries contributing flow from the north and south sides of the valley. The proposed access corridor for the Shaw Creek hillside parallels Shaw Creek along the north side of the stream and crosses multiple named and un-named tributaries. Shaw Creek has a total drainage area of approximately 392 sq mi (250,880 acres), of which 53 sq mi, (33,920 acres) are upstream of the crossing of the proposed access corridor for the Shaw Creek hillside. The drainage basin ranges in elevation from 950 ft to 4,126 ft, for a total relief of approximately 3,200 ft.

The Shaw Creek channel is generally on alluvial/colluvial fill material, is relatively straight in the upper moderate gradient reaches, and becomes highly meandering in the mid-reaches and lower reaches. Some braiding occurs within a broad brushy plain in the lower reaches near the confluence with the Tanana River (Figure 2.4-3).

3.5.2 Stream Flow

Stream flow characteristics depend on the specific features unique to each drainage basin, such as size, shape, geology, topography, vegetative cover, and climate. Flows in the rivers and streams of central Alaska are driven by snowmelt, rainstorm runoff, and groundwater discharge. The high flow periods are a result of meteorological events such as thunderstorms and spring breakup/snowmelt. A discussion of the meteorology as it pertains to surface hydrology is presented below in Section 3.5.4 (Site Meteorology). Base flows in the area streams are the result of groundwater discharge. The flow regime of streams and rivers in the project area vary and range from ephemeral, for small unnamed drainages, to perennial for mid-sized creeks, to rivers such as the Goodpaster River. The major perennial streams experience their highest flows during May through September, and flows typically peak in late May. Precipitation records show that the peak period of precipitation occurs at almost the same time, with June, July, and August the months of peak precipitation. The timing of peak precipitation suggests that peak discharges for area streams are driven by snowmelt, and are supplemented or sustained through the summer by rainfall until fall freeze-up. The lowest flows occur during the winter months, caused by the extremely cold climate without mid-winter thaws that might generate snowmelt runoff. Winter base flow is supplied by groundwater discharge.

Continuous data for stream flow monitoring is not available for most of the streams within the project area, but instantaneous discharge measurements have been made on a number of streams and gauging/sampling locations throughout the project area. Locations of hydrologic monitoring stations are shown in Figure 3.5-1. Stream flow data have been compiled by Beckstead (2000). Discussion of stream flow quantity here is expressed in cubic feet per second (cfs). One cfs is equivalent to 448.8 gpm.

Flow records indicate that smaller creeks in the project area behave hydrologically differently than larger creeks, as would be expected. The computed annual volume of watershed runoff for smaller creeks (Sonora and Central) is 3.5 inches to 3.8 inches per year. The Goodpaster River, as a large watershed, produces approximately 6.2 inches per year (Beckstead, 2000) to 8.1 inches per year (Beckstead, 2002a). The difference between small and large watershed yields may be due to a number of factors including differences in groundwater recharge/discharge and differences in watershed elevation, slope-aspect composition (Beckstead, 2000), and the presence or absence of shallow aquifer recharge, storage, and release. The following discussion provides more detail for the three principal drainages that may be affected by this project.

Liese Creek Flows

Mean annual flow data from U.S. Geological Survey (USGS) gauging station records on Liese Creek (USGS Sta. No. 15477730) have been compiled (Beckstead, 2000). The continuous flow gauging station on Liese Creek encompasses 690 acres (1.08 sq mi) of the upper portion of the watershed. The total Liese Creek watershed has a drainage area of 2.2 sq mi. Because Liese Creek is an intermittent stream that has no flow during substantial portions of the year, there is limited continuous data for this creek. The no-flow period for Liese Creek appears to be November through April, although dry periods also have been observed in the summer months.

For the period of record that does exist (portions of 1999, 2000, and 2001 during periods of discharge), the typical flow was between 0.5 to 2.0 cfs. Peak flows as high as 6.1 cfs have been recorded.

Liese Creek presents a complex flow environment involving the alluvial/colluvial fill and subsurface flows. Observations suggest that the stream has losing and gaining reaches as the flow submerges into the valley fill and resurfaces down gradient.

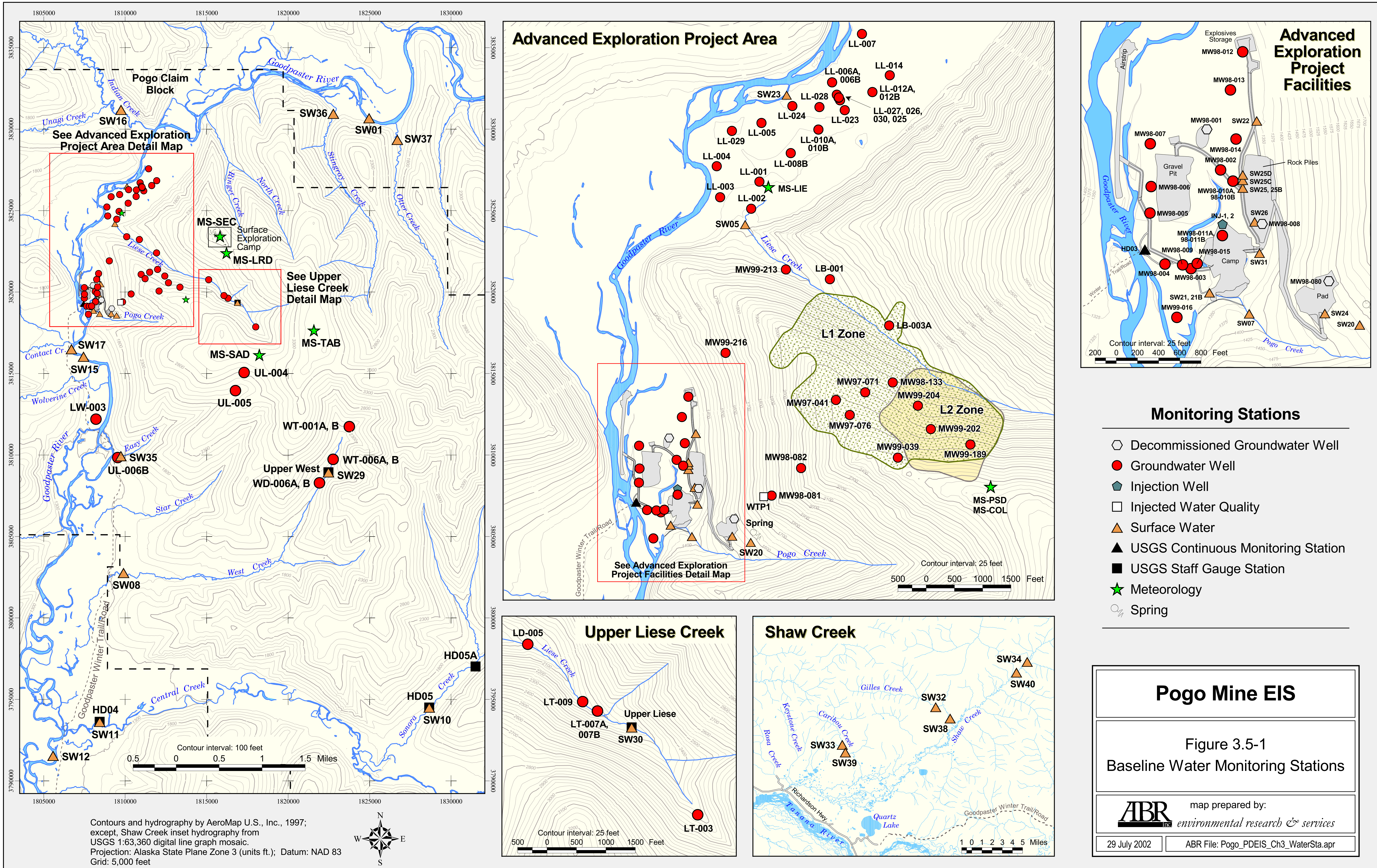


Figure 3.5-1
Baseline Water Monitoring Stations

Goodpaster River Flows

The Goodpaster River has been equipped with stations that monitor continuous flow since 1997 (Hoefler Consulting Group, 2001) (Figure 3.5-1). In 1998, the USGS assumed responsibility for the station near the project site. The Goodpaster is a perennial stream with continuous flow all year. Review of the monitoring data shows that the mean monthly base flows are approximately 50 cfs to 60 cfs during the winter months of November through April, while mean monthly discharges reach as high as 950 cfs, but are typically within the range of 400 cfs to 600 cfs, between May and September (Beckstead, 2000). Figure 3.5-2 presents the hydrograph of mean daily flow for the period of record from August 1997 to October 2001.

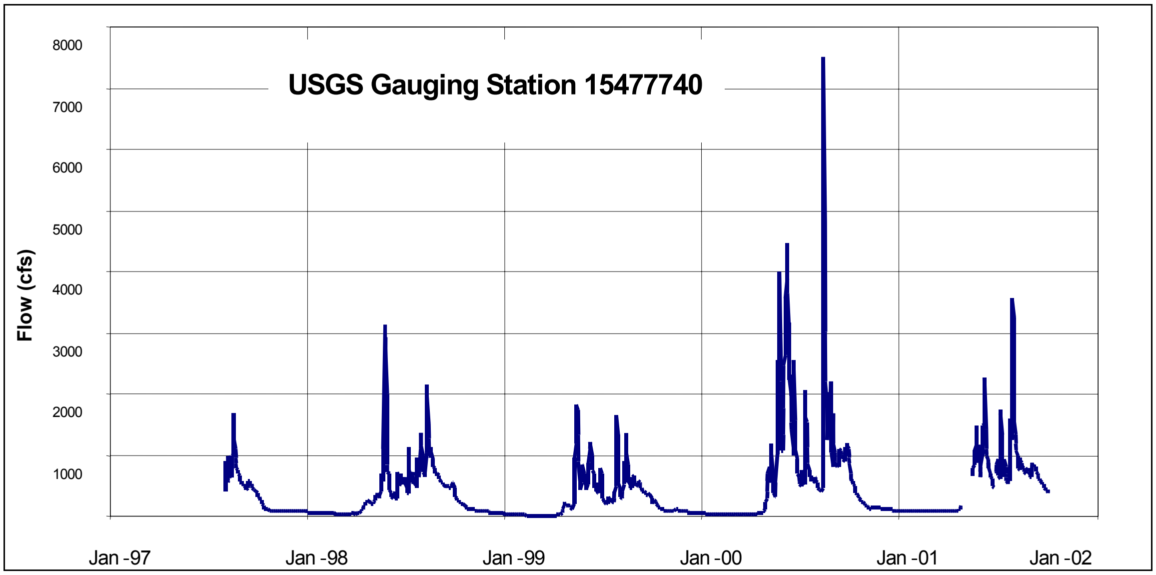
This hydrograph shows the wide variation in flow on a seasonal basis where the mean monthly discharge varies by a factor of 10 from approximately 60 cfs to more than 600 cfs. For the 5-year period of record, the minimum recorded mean daily flow was 10 cfs and the maximum recorded mean daily flow was 7,500 cfs. Discharge monitoring of other smaller watersheds (Central Creek and Sonora Creek) show similar maximum-to-minimum ratios of mean monthly flows, suggesting similar hydrologic responses, although on somewhat smaller scales. This historic data provides useful information for evaluating ungauged watersheds in the area. Figure 3.5-3 presents a plot of the frequency distribution of mean daily flow data for the period of record for the Goodpaster River. This flow characterization suggests that the flow regime is dominated by flows in the range of 50 cfs to 100 cfs. A secondary spike of flow frequency is shown at approximately 650 cfs to 700 cfs, representing the seasonal high flow.

An important aspect of understanding the flow regime of a stream and the susceptibility to environmental impacts is the extreme-low-flow condition. Because of the limited period of record, a statistically derived extreme-low-flow condition from measured flow data for the Goodpaster River is not possible. The estimated 7-day low flow at a recurrence interval of once in 10 years (7Q10) is estimated to be 18 cfs near the mine facilities (Teck-Pogo Inc., 2002d). This low flow was estimated based on a statistical comparison with the Salcha River, for which a long period (53 years) of record is available (Beckstead, 2002b). The period of record (5 years) for the Goodpaster shows 67 days during which the flow has been at 18 cfs or less. This high frequency of low flow reflects the extreme drought conditions experienced during 1999. The minimum monitored flow of 10 cfs is estimated at a recurrence interval of once in 100 years for drought flow condition.

Shaw Creek Flows

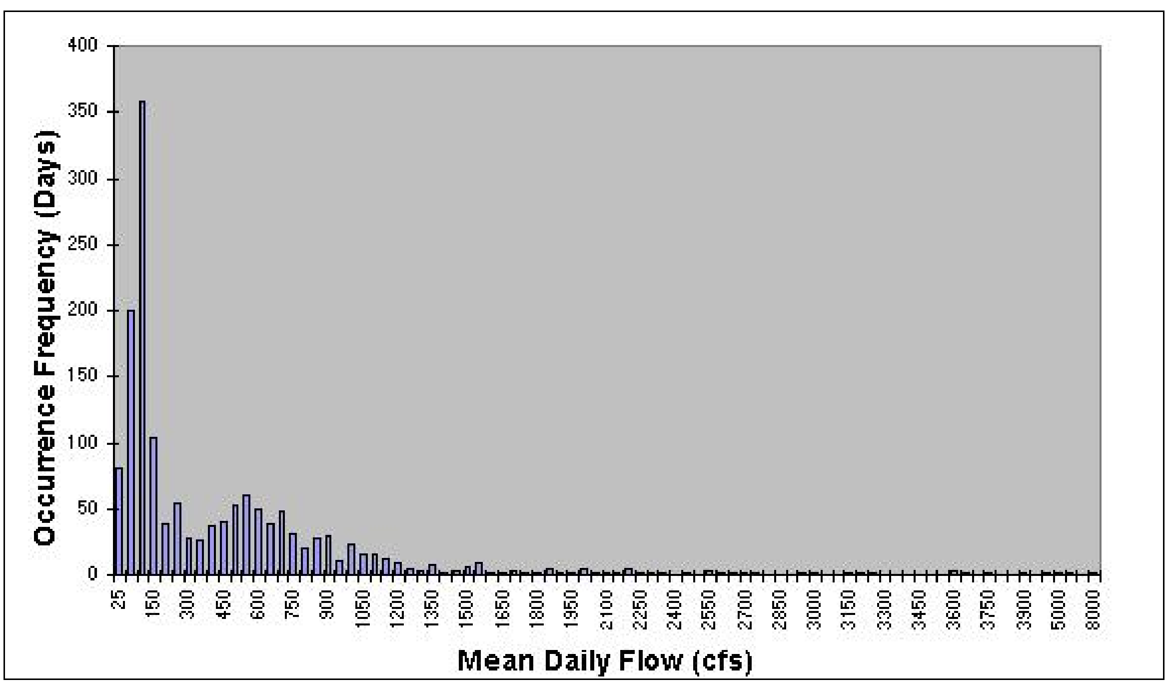
The flow regime of Shaw Creek is considered to be perennial. This stream currently has no USGS station providing monitoring of continuous stream flow; therefore, little flow data exists to characterize the discharge hydrology. Discharge measurements were made during water quality and stream survey work conducted as part of the environmental baseline studies for the Pogo Mine. The Shaw Creek watershed differs little from surrounding watersheds, suggesting that the hydrologic response of this watershed is probably quite similar to other gauged watersheds nearby. As described for Liese Creek and the Goodpaster River, the base flows are likely a result of groundwater discharge, while higher flows are responses to rainfall and snowmelt.

Figure 3.5-2 Goodpaster River Mean Daily Flow Hydrograph



Source: Teck-Pogo Inc. (2002d)

Figure 3.5-3 Goodpaster River Mean Daily Flow Frequency Distribution 1997-2001



Source: EDE (2002)

3.5.3 Flood Estimates

Determination of flood flows with the use of stream flow data requires a substantial period of monitoring record to provide a statistically defensible estimate. Stream flow monitoring on the watersheds within or adjacent to the project area and the access corridors covers a relatively brief period of time and is insufficient to provide flood flow estimates based on stream flow measurements. Flood flows can be estimated by other techniques, including comparison to similar watersheds with a substantial gauging period, or can be based on rainfall-runoff relationships and good rainfall frequency distribution data. The estimates for flood flow frequency presented here (Table 3.5-2) were determined with the regression analysis of similar regional watersheds as presented by Jones and Fahl (1994).

Table 3.5-2 Flood Frequency Estimates

Drainage Name	Flow Estimates (cfs)[1]					
	Q2	Q5	Q10	Q50	Q100	Q200
Rosa Creek[2]	200			795	934	
Rosa Creek[3]	180			710	834	
Keystone	160			630	742	
Caribou Creek	300			1,110	1,285	
Gilles Creek	430			1,570	1,820	
Shaw Creek[4]	510			1,830	2,115	
Wolverine Creek	30			130		
Goodpaster River[5]	5,800	8,770	10,600	14,500	16,000	17,500
Liese Creek[6]	15	46	51	93	112	158
Liese Creek[7]	24	71	99	137	165	231

1 Teck-Pogo Inc. (2002b). Method of Jones and Fahl (1994), flow values for return intervals (occurrence frequency) of 2, 5, 10, 50, 100, and 200 years.
2 Lower gauging station
3 Upper gauging station
4 At Shaw Creek Hillside Route corridor crossing
5 At exploration airstrip
6 At dam for recycling tailings pond
7 At mouth

3.5.4 Site Meteorology

The climate of the area is classified as continental, which is characterized by large diurnal and annual temperature variations, low precipitation, low cloudiness, and low humidity. Surface winds are generally light, but can be affected by local topography (Selkregg, 1976).

The mine site is typical of other areas of central interior Alaska. Extreme cold conditions in the winter (-40ºF to +32ºF) and moderate temperatures in the summer (+41ºF to +86ºF) are characteristic (National Oceanic and Atmospheric Administration [NOAA], 2002) The meteorology of this site is particularly important to the surface water hydrology because the streams are nonglacial and stream flow is driven by melting of winter snow pack and summer rain showers and thunderstorms.

The closest meteorological station collecting long-term meteorological data is at Big Delta, approximately 36 miles southwest of the proposed mine site. At Big Delta, mean annual precipitation is 11.5 inches and mean annual snowfall is 41.3 inches (Leslie, 1989). Because meteorological data was not available for the mine site, six meteorological monitoring stations were operated through various times and at various locations at the site since 1996. Much of this period was characterized by relatively dry to extreme drought conditions, as reflected in the hydrologic analysis of gauged watersheds in this region.

Evaporation data was collected for the site during the summer months of 1998 and 1999. The evaporation pan was located at the MS-SEC site (Beckstead, 2000).

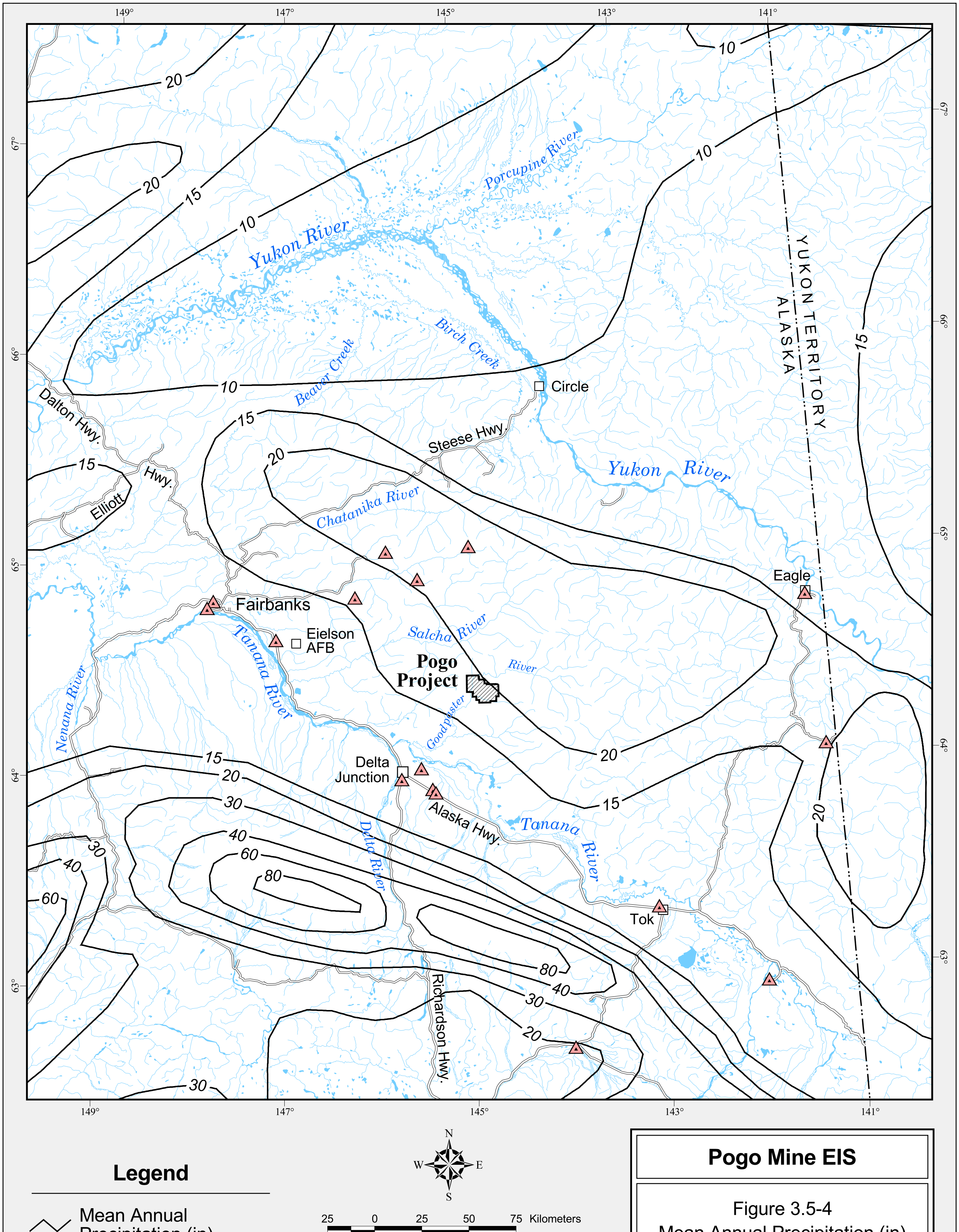
Extensive analysis of long-term records of snow pack, rainfall, and watershed yield was conducted during the baseline hydrologic studies and subsequent supplemental analysis. The result of this work estimated the average annual precipitation for the mine site to be 19 inches per year. This value was based on the USGS estimation of mean annual precipitation for west central Alaska (Jones and Fahl, 1994). The general regional precipitation map from the USGS is presented as Figure 3.5-4. Seasonal distribution of precipitation was determined from meteorological data collected on site, as well as the 61-year period of record at Big Delta (1937-1998). These data show the peak precipitation months are May through September. The least precipitation occurs during the winter and comes in the form of snow. The wettest month of the year appears to vary by year for site data, but is shown to be July for Big Delta precipitation data (Beckstead, 2000).

The distribution of precipitation with respect to topography and elevation (orographic effect) shows the period of record for meteorological stations at the site is short. As a result of the limited data set, determination of whether an orographic effect exists is difficult (Beckstead, 2000). More factors than a simple elevation-precipitation relationship play into true orographic effects for site-specific precipitation determination. Drawing from more extensive data in areas of similar climate and topography of central Alaska and the Yukon region (304 climatological stations, 102 snow survey sites, and 223 stream flow stations), it has been estimated there is roughly an 11 percent increase in precipitation for a 305-ft (100-meter) increase in elevation (Pullman, 2000). The proportion of this orographic effect shifts from rainfall to snow with increasing elevation, as would be expected (Clearwater Consultants, 1996).

As stated in the stream flow discussion, there is a reasonable and clear relationship between seasonal distribution of precipitation and stream flows. Simply put, the surface water hydrologic regime of the project area is strongly dependent on the quantity and time distribution of precipitation.

3.5.5 Vessel Navigation

There are approximately 70 cabins between the mouth of the Goodpaster River and river mile 36; five cabins between mile 36 and 56; three cabins above mile 56, one of which is above the proposed bridge location at the mine site at mile 68. During high use periods, it is not uncommon for between 25 and 40 recreational riverboats to use portions of the lower 33 miles of the river (below the South Fork) during a given weekend. On holiday weekends, as many as 60 to 75 recreational riverboats may use the lower Goodpaster River. The largest vessels operating on the Goodpaster River below South Fork are typically 24- to 26-foot inboard riverboats (Parker, 2003; Nay, 2003).



Legend

Mean Annual Precipitation (in)

NWS and NRCS Meteorological Stations

Precipitation contours (in) after USGS 1993; 1:2,000,000 scale
Map base: US DMA DCW
Projection: UTM Zone 6
Datum: NAD 27

Pogo Mine EIS

Figure 3.5-4
Mean Annual Precipitation (in)

ABR inc environmental research & services

19 August 2002

ABR File: Pogo_PDEIS_Ch3_Precip.apr

The proposed Goodpaster River bridge location is approximately 1,150 feet downstream, and 150 feet upstream, of bends in the river (Figure 2.3-1a). At this location, the river has a pool and riffle channel configuration, with pools of a few feet depth and riffles 1 to 2 feet in depth. The shallow normal depths of the river encountered at the proposed bridge location (2 to 4 feet between piers 1 and 4, zero between piers 4 and 6, 1 to 2 feet between piers 6 and 7) are a limiting factor on the size of watercraft that can navigate the river. The river at this location is navigable by recreational riverboats up to 20 feet in length (primarily jet boats) during high water, with observed traffic over the last five years of 3 to 5 craft per year. Approximately 6 inflatable rafts and 2 or 3 canoes per year have been observed during the same time period on float trips originating from airstrips in the upper Goodpaster Valley (Hanneman, 2003c).

Man-made structures modifying the flow regime or flow characteristics are nonexistent. There is no commercial navigation on the Goodpaster River at present, and no foreseeable commercial uses. There are no local service facilities. There are no vessels engaged in national defense activities or channel maintenance on the river. The COE has not completed a federal navigation project on the waterway and no guide clearances have been established for the waterway. Clearance gauges, however, are not necessary for the existing river traffic (Hanneman, 2003c).

3.6 Groundwater Hydrology

3.6.1 Hydrogeologic Setting and Sources of Data

Groundwater resources in the mine area occur in two main hydrogeologic environments. Ground water occurs under unconfined conditions in sand and gravel alluvial aquifers in association with streams and the Goodpaster River. Ground water also occurs in a fractured bedrock aquifer. Ground water in all aquifers tends to flow toward the Goodpaster River.

Groundwater data are available from an extensive collection program that included a monitoring well network (Figure 3.5-1), underground adit development, and underground test hole drilling. Hydraulic tests were performed at a production well in the Goodpaster Valley and at other wells and boreholes using packer techniques. Data also were obtained from isotope and geochemical studies, water level monitoring, water discharge measurements from the adit, and groundwater flow modeling. Unless otherwise cited, hydrogeologic information summarized below is derived from Brown (2002).

3.6.2 Geologic Units

This section describes geologic units present at the mine site. The geologic history of the area is described in more detail above in Section 3.1 (Geology).

Soil and Colluvial Deposits

Surficial soil and colluvial deposits are present through the upland areas and on steep slopes. Soils and colluvium are derived from local bedrock sources through mass wastage processes. There are no known glacial deposits in the area. The thickness of soil and colluvium ranges from 0 ft to an estimated 100 ft, depending on location. Discontinuous permafrost occurs in these deposits in some areas, especially on north-facing slopes.

Alluvial Deposits

Alluvial deposits occur in the Goodpaster River Valley and in the bottoms of contributory stream valleys such as Liese Creek and Pogo Creek. Alluvial deposits in general consist of silts and sands, with lenses of gravel, cobbles, and boulders. The alluvium in the Goodpaster Valley is at least 100 ft thick and contains permafrost along the valley margins. Alluvium in the Liese Creek drainage is present up to a maximum thickness of approximately 50 ft.

Bedrock

Bedrock in the area consists mainly of metamorphic gneiss with intrusive rocks that includes granite dikes and a diorite intrusive body. The gold-bearing ore is contained in two approximately parallel, tabular, gently dipping quartz sills or veins, each averaging approximately 15 ft in thickness and separated vertically by approximately 400 ft. The upper vein is known as the L1 quartz vein and contains the L1 ore body. The lower vein is known as the L2 quartz vein and contains the L2 ore body.

Rocks in the area are complexly folded and faulted. The locations of major identified faults are shown in Figure 3.6-1. Permafrost occurs in bedrock as deep as 300 ft in some locations, and is generally more prevalent and deeper on north- and west-facing slopes.

3.6.3 Groundwater Occurrence

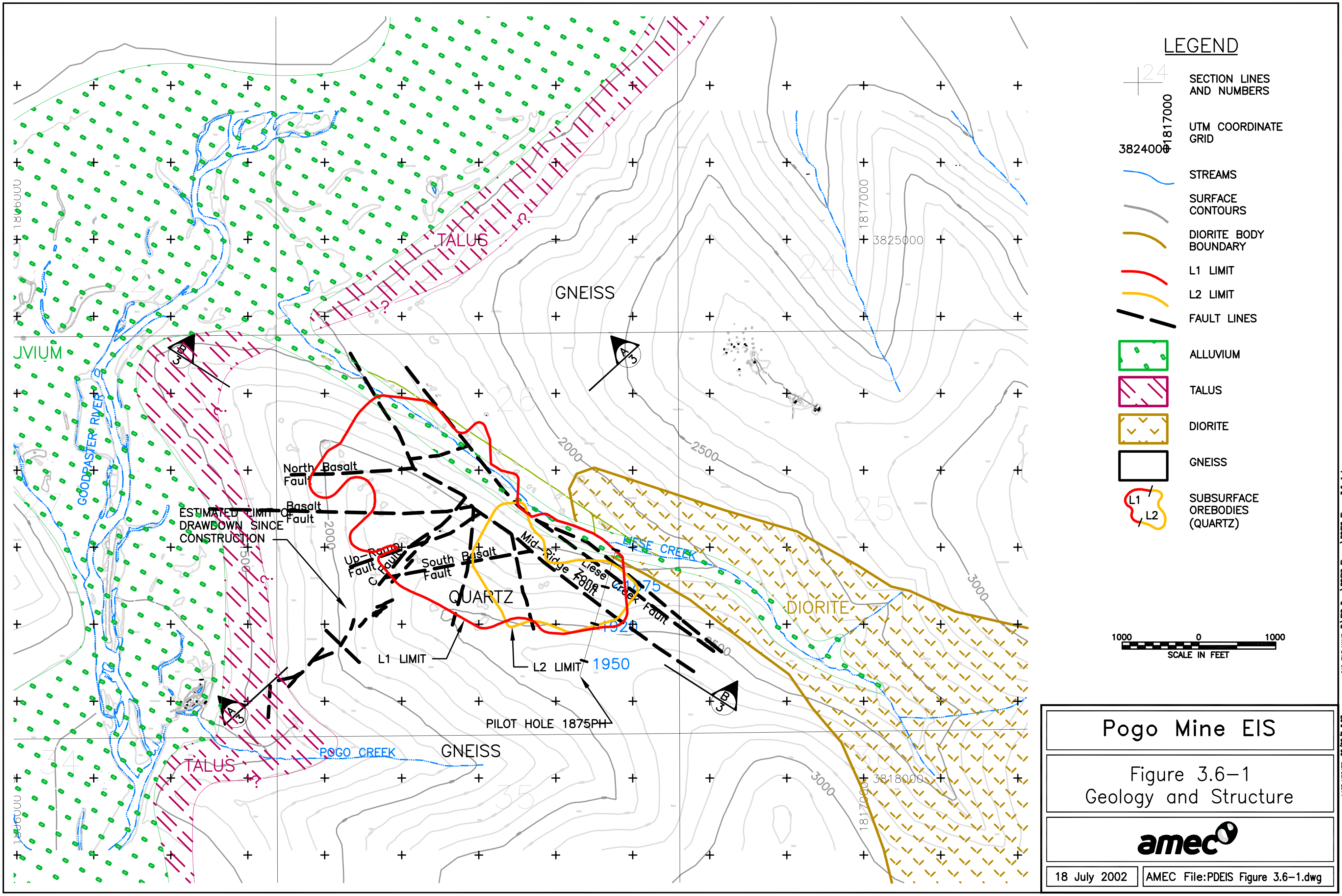
Ground water occurs under saturated conditions at depths ranging from the land surface near the Goodpaster River to 300 ft below ground surface beneath the ridge between Liese Creek and Pogo Creek. Ground water is recharged from snowmelt and rainfall in upland areas and from infiltration beneath creek beds in valleys. Ground water discharges to the Goodpaster River, except during peak flows.

Figure 3.6-2 shows a plan view representation of the potentiometric surface of the bedrock aquifer that was present prior to development of the exploration adit. The development of the adit resulted in a decline of groundwater levels in the vicinity of the adit and redirection of groundwater flows toward the adit, rather than toward the Goodpaster River.

The vertical relationships of the ore body, water levels, the adit, and other features are shown in two profiles through the area (Figure 3.6-3). The location of the lines of the profiles are shown in. The cross sections show that water level data collected from numerous boreholes that penetrated the ore body shows consistent results on the position of the potentiometric surface in the area.

Liese Creek Alluvial Aquifer

Ground water occurs in alluvium associated with Liese Creek. Water levels in wells near the creek are approximately 20 ft below creek level, indicating that the creek loses water to the alluvial deposits for most of its length. Some sections of the creek periodically go dry. An estimated average discharge of approximately 50 gpm flows through the Liese Creek alluvium down valley toward the Goodpaster River (Brown, 2002).



Pogo Mine EIS

Figure 3.6–1 Geology and Structure

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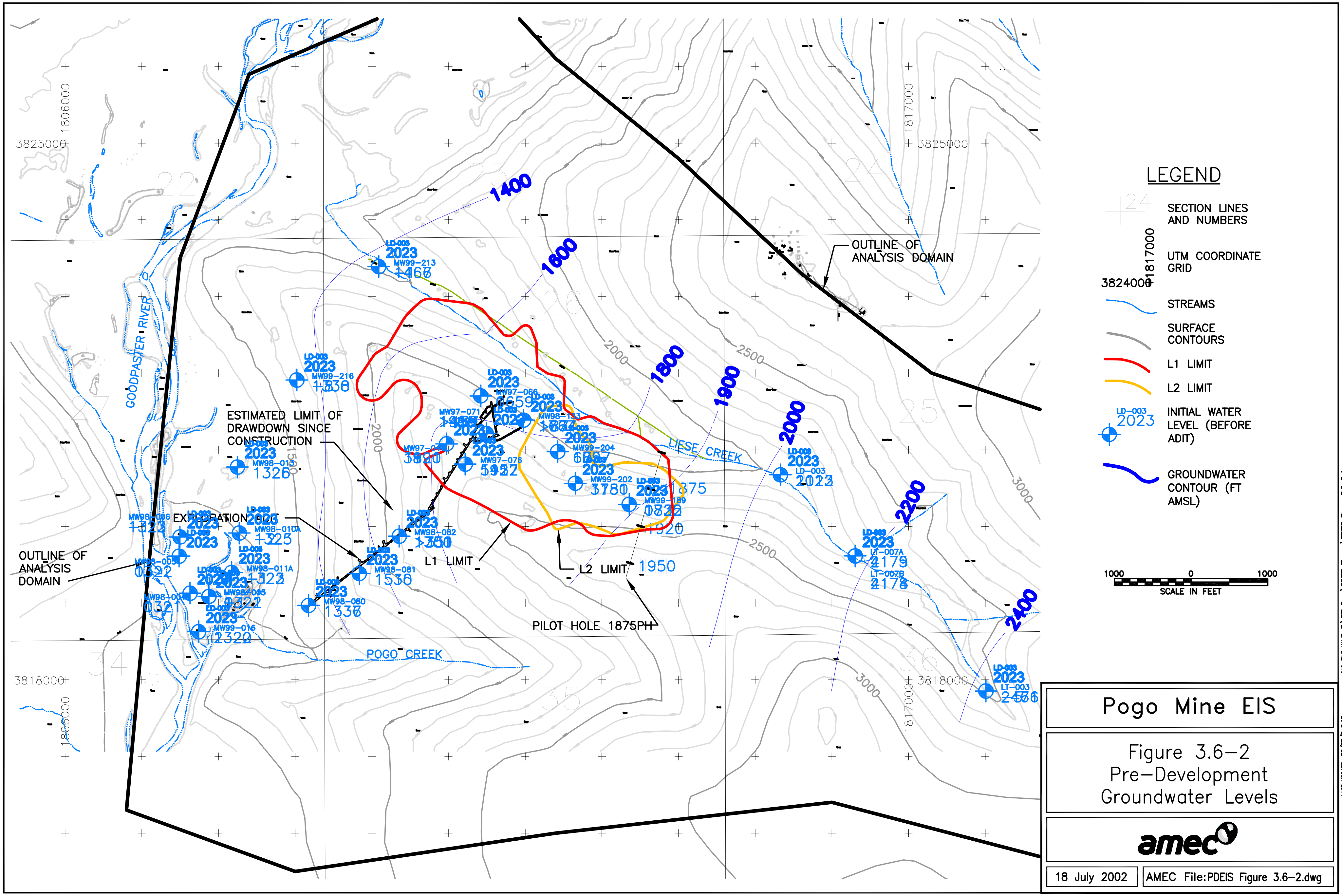

Pogo Mine EIS

Figure 3.6–2 Pre–Development Groundwater Levels

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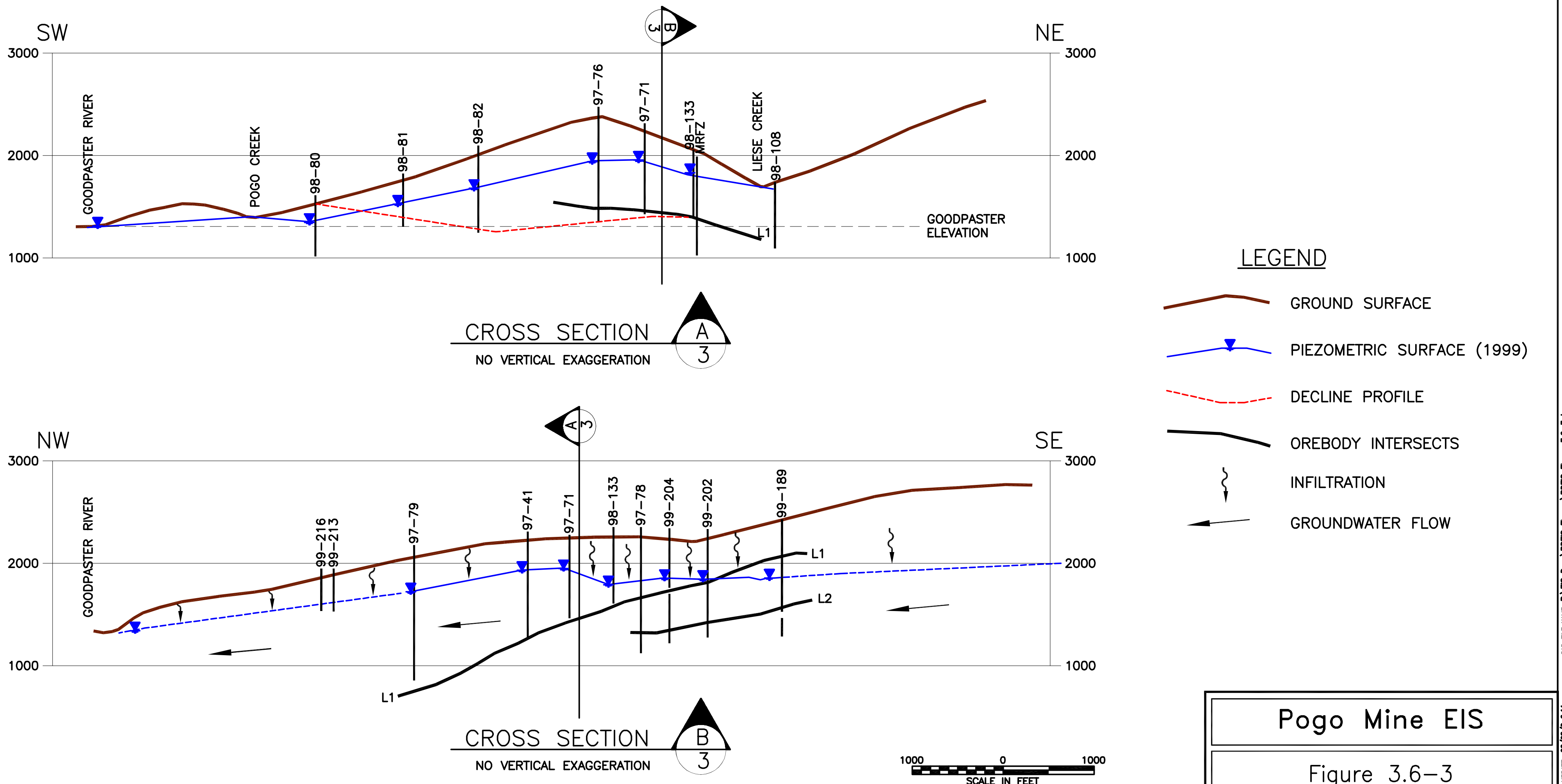

Pogo Mine EIS

Figure 3.6–3
Geologic Cross Sections

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Goodpaster River Alluvial Aquifer

The alluvial aquifer associated with the Goodpaster River is a major water-bearing aquifer in the area, capable of sustaining yields of hundreds of gpm to wells. The aquifer is unconfined, consists of sand and gravel, is more than 100 ft thick in the center of the valley, and thins toward the valley margins. Permafrost is present along the valley margins. The aquifer is recharged by precipitation, snowmelt, surrounding alluvial and bedrock aquifers and creeks, and spring and summer high flows of the Goodpaster River. The aquifer also presently receives treated drainage water from the exploration adit through two injection wells. Groundwater flows in the aquifer are generally down valley and toward the Goodpaster River. While groundwater discharges to the Goodpaster River most of the time, bank storage effects create variable groundwater flow directions during high water stages of the Goodpaster. Water levels in the Goodpaster River alluvial aquifer are generally within 4 to 6 ft of the land surface, because of the relatively flat valley-bottom topography.

During 2000-2001, two wells injected approximately 80 gpm of water into the Goodpaster alluvial aquifer (AMEC, 2001a). A third well has been constructed to test the hydraulic characteristics of the aquifer and provide additional injection capacity (Emmerson *et al.*, 2002). The well is screened from 38 to 75 ft below grade and has a demonstrated capacity to produce 390 gpm with 8.55 ft of draw-down in the pumped well. Based on a 72-hour pumping and recovery test with several monitoring wells, the transmissivity of the aquifer is estimated to be 0.015 square meters per second (m^2/s).

Subsequent injection testing at rates up to 250 gpm demonstrated that water table mounding of approximately 2 ft would occur near the injection well at that rate (Davies, 2002b). This mounding was observed with an increase in water levels in sloughs in the area by that amount. The mounding was not high enough to cause surface water discharge to the Goodpaster River through the sloughs.

Bedrock Aquifer

Ground water in bedrock occurs exclusively in fractures, faults, and joints. Data has been collected from vertical and angle holes drilled from the surface in the mine area, in the dry stack area, and from horizontal and angled holes drilled from the adit and from the 1875 elevation in Liese Creek Valley.

- **Surface Holes** Wells penetrating bedrock in the vicinity of the ore zone exhibit widely variable characteristics depending on their interception of water-bearing structures. In general, much of the rock mass contains low densities of water-bearing structures and has low hydraulic conductivities. The median hydraulic conductivity computed from 41 hydraulic tests conducted in vertical boreholes is 3 ft/yr, with values ranging from 0.01 ft/yr to 500 ft/yr. It was generally observed that hydraulic conductivity values were higher in the quartz ore body than in the country rock.
- **Dry Stack Area Holes** Hydraulic testing also was conducted in the area of the dry stack tailings southeast of the ore body. The median hydraulic conductivity was 33 ft/yr, an order of magnitude larger than values determined near the ore body. Near-surface weathering and fracturing due to stress relief of the rock mass are considered to be factors in explaining the higher hydraulic conductivities.
- **Underground (Adit) Holes** Much of the information about the characteristics of ground water in bedrock is from the adit. The adit is almost entirely constructed within

the zone of saturation. The adit encountered water-bearing structures and caused drainage of the mine area at time and spatial scales comparable to those for mine development. Radial holes were drilled along the adit to further test hydrogeologic properties. The median hydraulic conductivity values reported for 41 hydraulic tests is 5 ft/yr. Water flow rates from underground holes varied from 0 to 100 gpm; however, only 5 of 54 holes reported more than 20 gpm of flow.

Numerous faults and fault systems were mapped as a result of the adit development and underground boreholes (Figure 3.6-1). Most faults drained a small amount of water that dissipated with time. The two most significant water-bearing structures are the Mid-Ridge Fault and the Liese Creek Fault Zone.

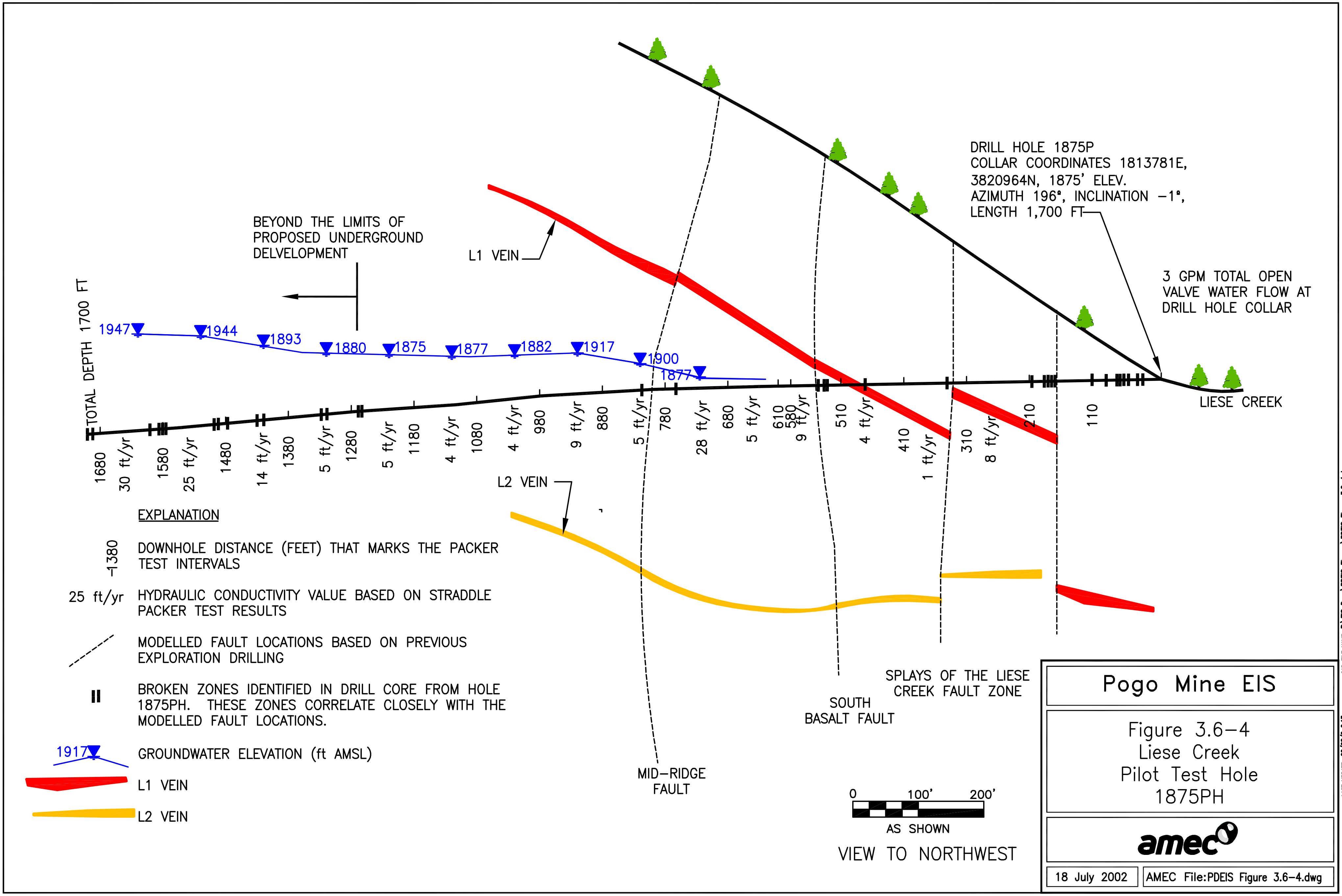
Two horizontal holes from the end of the adit penetrated the Mid-Ridge Fault and the Liese Creek Fault Zones. One hole (Hole 00U98C) produced a peak flow of 150 gpm and a sustained flow of 100 gpm. The calculated hydraulic conductivity from that hole for an assumed 100-ft aquifer thickness is 338 ft/yr, which is substantially higher than other values in the area. The other hole penetrating the fault zones exhibited minimal flow rates consistent with other holes in the area. Hole 00U98C shows that the Liese Creek Fault Zone has the potential to be a major water-bearing structure that is important for mine planning. The fault zone is located close to Liese Creek, which could present a substantial source of ongoing recharge to the fault zone and flow into the mine. There is considerable uncertainty in characterizing the hydraulic parameters of the Liese Creek Fault Zone as a result of the minimal amount of borehole data available for penetration of the zone. The discontinuous, fractured character of the aquifer also creates uncertainty about how the interconnectedness of aquifer fractures could change after development of the mine.

Approximately 1 year after initial development of the adit and the underground boreholes, groundwater drainage from the mine reached approximately 71 gpm. Flow from some of the underground boreholes was closed off to limit flows so that the capacity of the treatment and disposal system would not be exceeded.

As a result of drainage to the adit, water-level declines were observed in nearby wells, although the amounts of the declines were variable. More than 500 ft of water-level decline occurred adjacent to the adit and 31 ft of decline was observed 1,000 ft from the decline along the Mid-Ridge Fault. To illustrate the variability of hydraulic conductivity in the area, however, it should be noted that some wells located less than 300 ft from the adit showed water level declines of less than 32 ft.

- **1875 Pilot Hole** A nearly horizontal 1,700-ft borehole was drilled from the surface near Liese Creek at an elevation of 1,875 ft to penetrate the Liese Creek Fault Zone and the Mid-Ridge Fault to provide data for a proposed access decline at that location (Figure 3.6-4).

  Maximum observed flow of water from the hole was 3 gpm. Straddle packers were used to conduct 15 hydraulic tests in the hole, resulting in a median hydraulic conductivity of 5 ft/yr, with a range from 1 ft/yr to 28 ft/yr. The 1875 Pilot Hole is located approximately 2,000 feet up-valley from Hole 00U98C, which illustrates that the fault zones in the area are not uniform and can produce substantially different quantities of water in different areas.


DRILL HOLE 1875P
COLLAR COORDINATES 1813781E, 3820964N, 1875' ELEV.
AZIMUTH 196°, INCLINATION −1°,
LENGTH 1,700 FT
3 GPM TOTAL OPEN VALVE WATER FLOW AT DRILL HOLE COLLAR
BEYOND THE LIMITS OF PROPOSED UNDERGROUND DELVELOPMENT
L1 VEIN
L2 VEIN
TOTAL DEPTH 1700 FT
1947
1944
1893
1880
1875
1877
1882
1917
1900
1877
1680
30 ft/yr
1580
25 ft/yr
1480
14 ft/yr
1380
5 ft/yr
1280
5 ft/yr
1180
4 ft/yr
1080
4 ft/yr
980
9 ft/yr
880
5 ft/yr
780
28 ft/yr
680
5 ft/yr
610
580
9 ft/yr
510
4 ft/yr
410
1 ft/yr
310
8 ft/yr
210
110
LIESE CREEK
MID−RIDGE FAULT
SOUTH BASALT FAULT
SPLAYS OF THE LIESE CREEK FAULT ZONE
EXPLANATION
−1380 DOWNHOLE DISTANCE (FEET) THAT MARKS THE PACKER TEST INTERVALS
25 ft/yr HYDRAULIC CONDUCTIVITY VALUE BASED ON STRADDLE PACKER TEST RESULTS
MODELLED FAULT LOCATIONS BASED ON PREVIOUS EXPLORATION DRILLING
BROKEN ZONES IDENTIFIED IN DRILL CORE FROM HOLE 1875PH. THESE ZONES CORRELATE CLOSELY WITH THE MODELLED FAULT LOCATIONS.
1917 GROUNDWATER ELEVATION (ft AMSL)
L1 VEIN
L2 VEIN
0
100'
200'
AS SHOWN
VIEW TO NORTHWEST
Pogo Mine EIS
Figure 3.6−4
Liese Creek
Pilot Test Hole
1875PH
amec
18 July 2002
AMEC File:PDEIS Figure 3.6−4.dwg

Summary Detailed review of all the hydraulic testing results shows that the rock mass is generally of low hydraulic conductivity with an overall median measured value of 5 ft/yr. Shallower zones tested (such as near the dry stack tailings) and the Liese ore zones generally have higher hydraulic conductivities. Estimates of hydraulic conductivities considered representatives of the different rock types in the area are:

- Ore body 5 ft/yr
- Country rock 0.5 ft/yr
- Near-surface rock 50 ft/yr

Vertical fracturing is probably more ubiquitous and probably more continuous than horizontal fracturing, resulting in higher average vertical hydraulic conductivities compared to horizontal hydraulic conductivities.

Groundwater Recharge

Groundwater flow systems in the area are recharged by infiltration of rainfall, snowmelt, and runoff. Areawide average rates of infiltration are estimated to be approximately 0.5 to 1 inch/yr, which is approximately 3 to 5 percent of average annual precipitation. Infiltration as a percentage of precipitation is lower than in many other lower elevations, lower latitude locations because of the presence of discontinuous permafrost, steep slopes, thin soils, bedrock with low hydraulic conductivity, and the typical intensity of rainfall and snowmelt events. Seepage losses to ground water from Liese Creek are inhibited by the intermittent flow of the creek and the silty sands present in the creek bottom.

3.7 Water Quality

3.7.1 Surface Water Quality

Surface water in the Pogo project area is clear and nonglacial, with slight to moderate organic staining observed during spring runoff. The surface water environment is generally pristine and overall water quality and physical characteristics are typical of unpolluted subarctic Alaska streams (Balding, 1976; Emery *et al*., 1985; Feulner *et al*. 1972). The water quality in the Goodpaster River is of a higher quality than in smaller tributary streams that are near the Pogo deposit, i.e., Liese (SW05 and SW30) and Pogo creeks (SW07) (Figure 3.5-1). Water quality and physical characteristics are influenced by the source of the stream flow, which varies seasonally. During the open water season – approximately late April through October – the source of stream flow is a combination of groundwater base flow and precipitation runoff. As discussed in Section 3.5 (Surface Water Hydrology), freezing conditions in the winter limit the source of stream flow to groundwater inputs.

Acquisition of baseline data for surface water quality in the Pogo project area was initiated in September of 1996, and routine sampling began in spring 1997. Modifications were made to the baseline monitoring as the proposed project development alternatives evolved. Sampling of fine-grained bed sediment was added to the monitoring plan in the spring of 1998. The surface water and sediment monitoring are ongoing. In 2001, surface water and sediment sampling were conducted nine times. The monitoring schedule included monthly sampling from February through October.

Although water quality data was collected in 1996 and 1997, a fairly substantial revision of the monitoring program was made in 1998 to both the monitoring locations and analytical methods. From 1998 through 2001, a consistent set of stations and analytical methods were maintained, with the exception of the addition and deletion of a few stations. The 1996 and 1997 data generally supports the later sampling data; however, because of the modifications to the program, it is difficult to directly compare the results. Hence, this summary of surface water quality focuses on the 1998 through 2001 sampling.

The water and sediment quality monitoring program was developed to establish both spatial and seasonal baseline conditions within the surface water and fine-grained bed sediments prior to the start of mine development. Additional detail on the surface water and sediment quality baseline studies can be found in the project's environmental baseline document (Boggs, 2001a).

Baseline Monitoring Stations

Baseline water quality monitoring was conducted on an 11-mile reach of the Goodpaster River and a 21-mile reach of Shaw Creek, both tributaries of the Tanana River (Figure 3.5-1). Eighteen stations were sampled in the 2001 baseline monitoring program. Sampling stations in the Goodpaster River drainage included the following.

- Two stations upstream of the ore body and proposed project development and exploration activities (SW01 and SW23)
- One station just downstream of the advanced exploration camp at the confluence of Pogo Creek (SW15)
- One station farther downstream of the ore body and proposed project development (SW12)
- Ten stations located on tributary streams potentially affected by the ore body or project facilities (SW05, SW07, SW08, SW10, SW11, SW29, SW30, SW35, SW36, and SW37)
- Two stations located at springs near the advanced exploration camp (SW20 and SW22), although SW22 was not sampled in 2001

Six stations were located along the proposed Shaw Creek Hillside road alignment in the Shaw Creek drainage (SW32, SW33, SW34, SW38, SW39, and SW40). Stations SW32, SW,33, and SW34 were only sampled in 2000.

Stations on Indian Creek (SW16) and Dry Stack Tributary (SW17), located on streams potentially affected by project facilities proposed in 1998, are no longer being sampled as part of the baseline monitoring program because alternative locations for those facilities have been identified.

Water Quality Summary

Surface water in the Pogo project area is of the calcium bicarbonate type and is low to moderately hard at approximately 50 mg/L of hardness and not exceeding 70 mg/L. The surface waters sampled exhibit a nearly neutral pH. All surface waters sampled were well oxygenated during all seasons, with the average percent saturation of oxygen exceeding 86 percent. None of the measured water quality parameters subject to EPA priority pollutant standards for fresh water aquatic life exceeded the criterion maximum concentration (CMC) (EPA, 1998); however, a few samples did exceed the criterion chronic concentration (CCC). Lead exceeded the EPA CCC at

SW15 and SW30 on two and one occasions, respectively. Mercury exceeded the EPA CCC at SW15, SW23, and SW30 on two, two, and one occasions, respectively. EPA fresh water aquatic life standards for nonpriority pollutants were exceeded by aluminum concentrations for CMC at SW07, and for CCC at SW05, SW07, SW15, SW22, SW23, and SW30. The secondary maximum contaminant level (MCL) standard for iron was exceeded at SW01, SW05, SW15, and SW23. Iron also exceeded the CMC at stations SW01, SW15, and SW23.

A summary of the water quality for Goodpaster River stations SW01, SW15, and SW23 is presented in Table 3.7-1. This table presents the mean concentrations measured at each station. Stations SW01 and SW23 are upstream of the proposed Pogo facilities, and SW15 is downstream. A summary for the Liese and Pogo creeks stations SW05, SW07, and SW30 is presented in Table 3.7-2.

These data demonstrate that certain constituents are present at higher concentrations (both total and dissolved) in the small creeks draining from the site (SW05 and SW30 in Liese Creek and SW07 in Pogo Creek) than in the main stem of the Goodpaster River. This difference in concentrations was observed for aluminum, arsenic, chromium, and nickel. The plots in Figure 3.7-1 and Figure 3.7-2 also demonstrate the elevated concentrations of arsenic in the Liese Creek stations. Pogo Creek had elevated concentration of total suspended solids (TSS), as indicated in Table 3.7-2. The impact of this elevated solids content can also be observed in the higher total metals concentrations for a number of parameters. The higher TSS concentrations in Pogo Creek are attributed to naturally occurring processes and not to exploration activities (Boggs, 2001a). The Alaska Water Quality Criteria for these waters is published in 18 AAC 70 – Water Quality Standards. The standards/criteria for toxics are adopted by reference from EPA standards as presented in 40 CFR, Chapter 1, 131.36.

Figure 3.7-3 and Figure 3.7-4 present the total concentrations of selected trace metals, NO_3, and TDS as a function of time for stations SW01 and SW15, respectively. These stations are above and below the location of the Pogo ore body. Although some differences exist between the two stations, the plots are relatively similar. For example, the TDS plots are very similar between SW01 and SW15, but some differences can be seen for manganese between these two stations.

Table 3.7-1 Goodpaster River - Surface Water Quality

General Parameters	Units	SW01	SW01	SW15	SW15	SW23	SW23
Ammonia Nitrogen	mg/L	0.067		0.061		0.049	
Bicarb Alkalinity	mg/L	38		40		38	
Field pH	pH units	7.06		7.06		6.93	
Field Temperature	deg C	4.3		4.3		4.6	
Kjeldahl Nitrogen	mg/L	0.188		0.182		0.19	
Lab Turbidity	NTU	1.22		1.9		2.38	
Nitrate Nitrogen	mg/L	0.236		0.245		0.248	
Settleable Solids	mL/L/hr	< 0.1		<0.1		<0.1	
Total Suspended Solids	**mg/L**	**4.7**		**5.4**		**4.9**	
Alkalinity	mg/L	37		40		38	
Chloride	mg/L	0.37		0.35		0.35	
Total CN	mg/L	0.0052		0.0041		0.0038	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	50.5		52.8		50.7	
Sulfate	mg/L	14.9		16.9		15.3	
Dissolved O_2	mg/L	12.22		11.83		11.96	
Dissolved O_2 % Saturation	%	93.3		90.8		91	
Total Dissolved Solids	**mg/L**	**75**		**75**		**74**	
		SW01 Total	**SW01 Dissolved**	**SW15 Total**	**SW15 Dissolved**	**SW23 Total**	**SW23 Dissolved**
Metals	**Units**						
Aluminum	µg/L	66.6	25.2	67.5	21.9	82.1	23.5
Arsenic	µg/L	0.23	0.21	0.29	0.25	0.26	0.2
Barium	µg/L	15.9	15.37	16	15.28	15.7	14.84
Cadmium	µg/L	0.021	0.023	0.024	0.028	0.019	0.019
Calcium	mg/L	14.2	14.3	14.6	14.8	14.2	14.2
Chromium	µg/L	0.65	0.7	0.84	0.82	0.64	0.71
Copper	µg/L	0.72	0.67	0.83	1.3	0.68	0.66
Iron	mg/L	0.11	0.0295	0.135	0.0307	0.155	0.032
Lead	µg/L	0.055	0.021	0.436	0.265	0.089	0.054
Magnesium	mg/L	3.59	3.61	3.84	3.85	3.63	3.62
Manganese	µg/L	6.74	3.1	10.4	6.85	7.93	3.52
Mercury	µg/L	0.004	0.0035	0.0069	0.0036	0.0053	0.0039
Nickel	µg/L	0.56	0.54	0.59	0.58	0.45	0.45
Potassium	mg/L	1.186	1.184	1.24	1.197	1.253	1.117
Selenium	µg/L	0.5	0.5	0.6	0.6	0.5	0.5
Silver	µg/L	0.009	0.008	0.01	0.009	0.008	0.007
Sodium	mg/L	2.45	2.588	2.41	2.55	2.40	2.45
Zinc	µg/L	1.02	2.39	1.02	2.54	1.05	2.4
Number of Samples		**32**		**35**		**30**	

Source: Boggs (2001a)

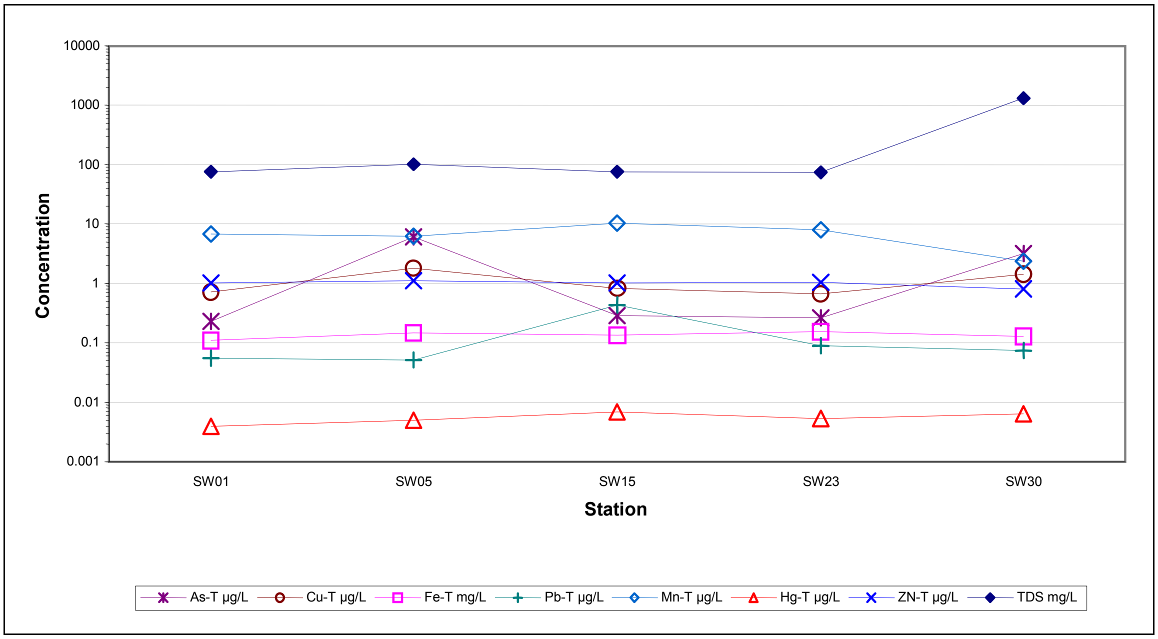
[1] Weak acid dissociable

Table 3.7-2 Liese and Pogo Creeks Surface Water Quality

General Parameters	Units	SW05	SW05	SW07	SW07	SW30	SW30
Ammonia Nitrogen	mg/L	0.154		0.184		0.024	
Bicarb Alkalinity	mg/L	43		58		40	
Field pH	pH units	7.06		7.15		6.82	
Field TEMP	deg C	3		1.9		1.3	
Kjeldahl Nitrogen	mg/L	0.5		0.42		0.36	
Lab Turbidity	NTU	2.5		162		0.9	
Nitrate Nitrogen	mg/L	0.83		0.67		0.88	
Settleable Solids	mL/L/hr	0.08		0.66		0.07	
Total Suspended Solids	**mg/L**	**3.1**		**588.9**		**4.6**	
Alkalinity	mg/L	44		55		40	
Chloride	mg/L	0.3		0.36		0.26	
Total CN	mg/L	0.0043		0.0072		0.0034	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	61.6		112		47	
Sulfate	mg/L	15.1		33		4.9	
Dissolved O_2	mg/L	13.1		13.6		24.2	
Dissolved O_2% Saturation	%	97.1		97.4		94.2	
Total Dissolved Solids	**mg/L**	**103**		**129**		**1332**	
Metals	**Units**	**SW05 Total**	**SW05 Dissolved**	**SW07 Total**	**SW07 Dissolved**	**SW30 Total**	**SW30 Dissolved**
Aluminum	µg/L	172.9	145.1	6317.5	122.4	203	152
Arsenic	µg/L	6.1	5.8	17	8.1	3.2	2.9
Barium	µg/L	18.2	17.8	73.1	17.4	18.5	17.9
Cadmium	µg/L	0.02	0.017	0.082	0.018	0.021	0.02
Calcium	mg/L	18.6	18.5	27.6	25.1	13.8	14.0
Chromium	µg/L	1.2	1.19	6.97	1.13	0.79	0.74
Copper	µg/L	1.8	1.8	11.6	2.1	1.43	1.4
Iron	mg/L	0.149	0.09	10.296	0.1	0.129	0.0628
Lead	µg/L	0.052	0.024	3.99	0.043	0.074	0.033
Magnesium	mg/L	4.01	4.02	9.34	6.83	2.98	2.98
Manganese	µg/L	6.18	4.98	156	30.09	2.38	0.77
Mercury	µg/L	0.005	0.0048	0.0238	0.0044	0.0064	0.0048
Nickel	µg/L	1.12	1.15	7.87	1.54	0.43	0.44
Potassium	mg/L	1.347	1.153	2.295	1	1	1
Selenium	µg/L	0.5	0.5	0.6	0.48	0.5	0.5
Silver	µg/L	0.016	0.009	0.029	0.008	0.007	0.007
Sodium	mg/L	1.729	1.61	3.357	3.038	1.057	1.179
Zinc	µg/L	1.11	2.59	15.5	2.8	0.8	2.12
Number of Samples		17		20		9	

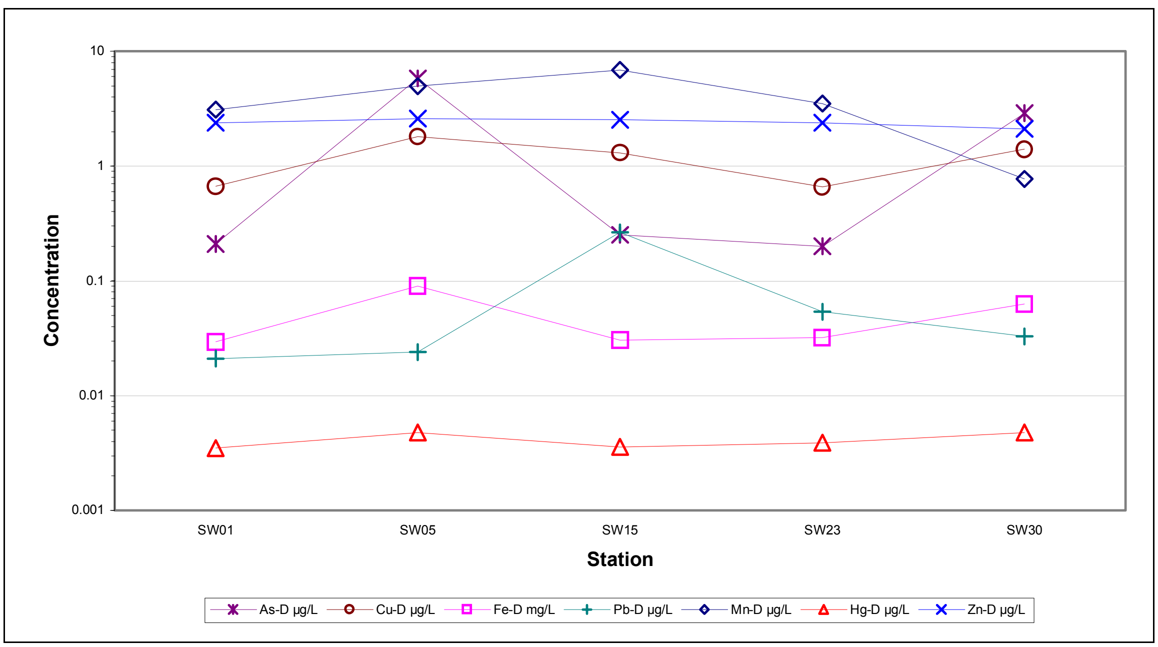
Source: Boggs (2001a)

Figure 3.7-1 Surface Water Quality: Average Total Trace Metal and TDS Concentrations at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

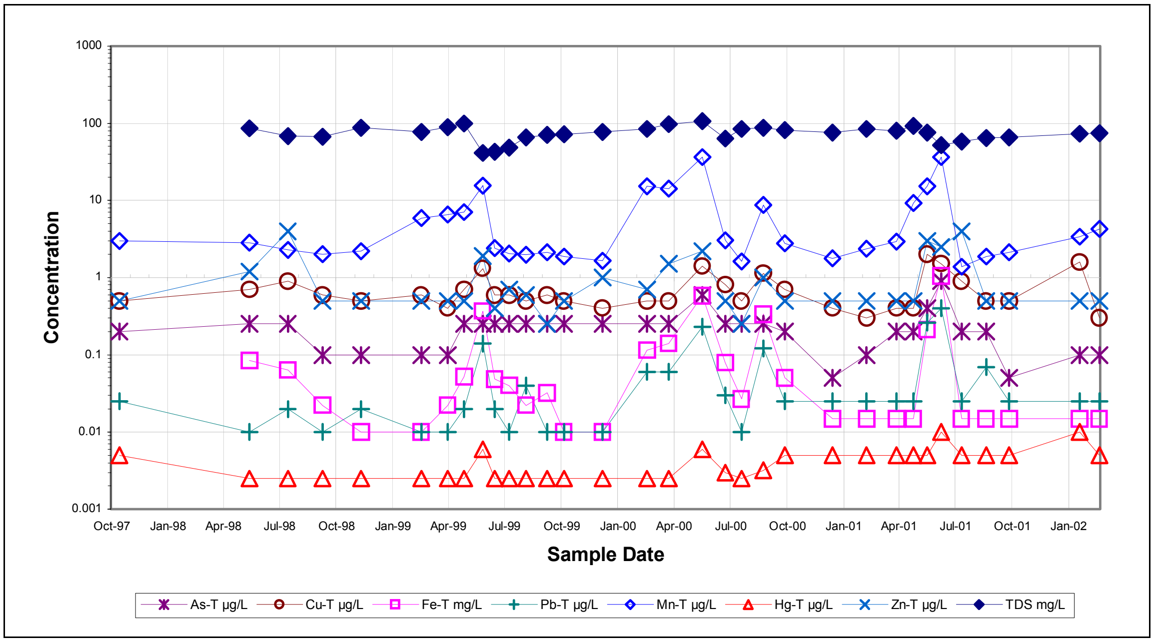
Figure 3.7-2 Surface Water Quality: Average Dissolved Trace Metal Concentrations at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

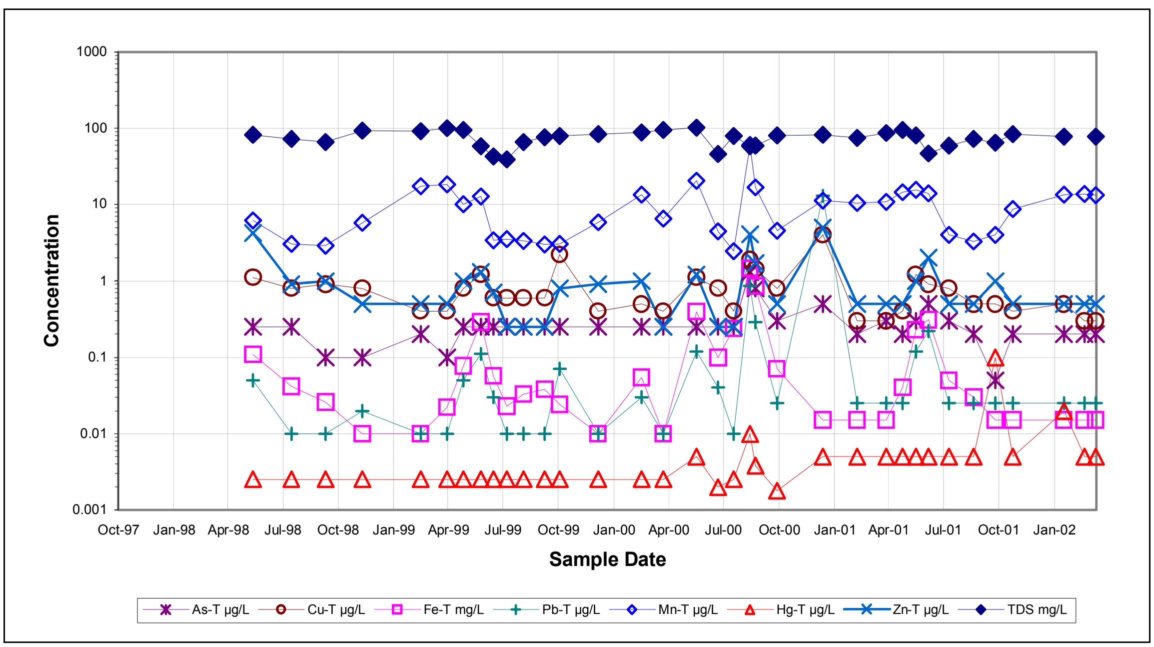
Notes: Data included in the Figures 3.7-1 and 3.7-2 are from sample class M, monitoring data, or sample class P, permit stipulated sample data. Results reported as less than the method reporting limit (<MRL) are set to 0.5 of the MRL for charting and statistical determinations. Total dissolved solids are noted as TDS.

Figure 3.7-3 Surface Water Quality at Station SW01: Total Trace Metal and TDS Concentrations over Time



Sources: Boggs (2001a) and Hanneman (2002b)

Figure 3.7-4 Surface Water Quality at Station SW15: Total Trace Metal and TDS Concentrations over Time



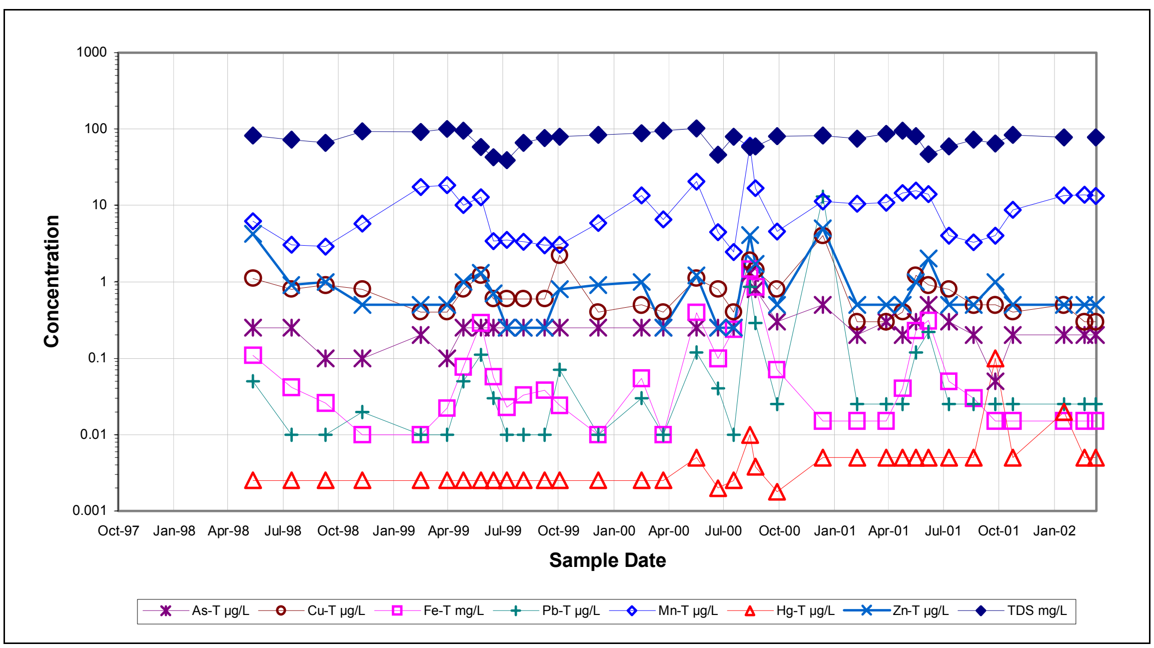
Sources: Boggs (2001a) and Hanneman (2002b)

Summary data for SW38, SW39, and SW40 are presented in Table 3.7-3. These stations are all located in the Shaw Creek drainage and represent Gilles Creek (SW38), Caribou Creek (SW39), and Shaw Creek (SW40). They are all located downstream of proposed crossings by the all season road. Three other stations in the Shaw Creek drainage (SW32, SW33, and SW34) are located upstream of stations SW38, SW39, and SW40, respectively. These stations had water quality results that were very similar to those presented in Table 3.7-3. In general, the stations in the Shaw Creek drainage had water quality that was similar to stations on the Goodpaster River such as SW01. Concentrations of most common ions were low (calcium, sodium, magnesium, and potassium) for the Shaw Creek stations. The concentrations of trace elements were low in general; however, SW39 (Caribou Creek) did have higher concentrations of both total and dissolved manganese on average than stations on the Goodpaster River or stations on other creeks in the Shaw Creek Drainage. For example, total manganese at SW39 averaged 118 micrograms per liter (μg/L) compared with 6.7 μg/L at SW01 on the Goodpaster River.

Sediment Quality

A summary of sediment quality sampling is shown in Figure 3.7-5. This figure presents the mean and standard deviation of sediment analyses at selected stations in the Goodpaster River and Liese Creek. The results demonstrate that the highest concentrations of arsenic and silver were present in Liese Creek (SW05 and SW30) compared to the stations on the Goodpaster River (SW01, SW15, and SW23).

Figure 3.7-5 Sediment Quality (1998-2001): Average Trace Metal Concentrations in Fine-grained Bed Sediments at Selected Sampling Stations



Sources: Boggs (2001a) and Hanneman (2002b)

Table 3.7-3 Shaw Creek Valley Surface Water Quality

General Parameters	Units	SW38	SW38	SW39	SW39	SW40	SW40
Ammonia Nitrogen	mg/L	0.04		0.05		0.03	
Bicarb Alkalinity	mg/L	42		60		70	
Field Conduct	µS/cm	81.7		81.1		106	
Field pH	pH units	6.58		6.57		6.66	
Field Temperature	deg C	7.5		5.8		6.1	
Kjeldahl Nitrogen	mg/L	0.13		0.26		0.16	
Lab Turbidity	NTU	0.8		4.2		1.8	
Nitrate Nitrogen	mg/L	0.232		0.143		0.295	
Settleable Solids	mL/L/hr	0.08		0.18		0.08	
Total Suspended Solids	**mg/L**	**2.1**		**15.4**		**3.5**	
Alkalinity	mg/L	42		60		70	
Chloride	mg/L	0.25		0.46		0.25	
Total CN	mg/L	0.0025		0.0025		0.0025	
WAD CN	mg/L	0.0025		0.0025		0.0025	
Hardness	mg/L	60.6		73		86.1	
Sulfate	mg/L	23		20		23	
Dissolved O_2	mg/L	30.62		12.13		12.07	
Dissolved O2 % Saturation	%	77.22		96.1		97.1	
Total Dissolved Solids	**mg/L**	**86**		**118**		**115**	
Metals	**Units**	**SW38 Total**	**SW38 Dissolved**	**SW39 Total**	**SW39 Dissolved**	**SW40 Total**	**SW40 Dissolved**
Aluminum	µg/L	20	12	204	21	80	14
Arsenic	µg/L	0.3	0.3	1.5	1.1	0.5	0.4
Barium	µg/L	8.51	8.55	17.1	14	18.4	17.7
Cadmium	µg/L	0.025	0.025	0.025	0.025	0.025	0.025
Calcium	mg/L	14.225	14.6	17.9	18.4	21.275	22.225
Chromium	µg/L	0.25	0.25	0.51	0.25	0.25	0.25
Copper	µg/L	0.8	0.9	1.5	1.3	1.1	0.9
Iron	mg/L	0.278	0.188	1.587	0.822	0.26	0.117
Lead	µg/L	0.025	0.036	0.12	0.025	0.125	0.025
Magnesium	mg/L	5.725	5.875	6.45	6.575	7.425	7.725
Manganese	µg/L	23.5	21.2	117.7	85.3	44	36.7
Mercury	µg/L	0.005	0.005	0.005	0.005	0.005	0.005
Nickel	µg/L	0.38	0.6	1.3	1.2	0.5	0.45
Potassium	mg/L	1	1	1	1	1	1
Selenium	µg/L	0.5	0.5	0.5	0.5	0.5	0.5
Silver	µg/L	0.005	0.005	0.007	0.005	0.009	0.005
Sodium	mg/L	2.25	2.75	3.75	3.75	2.75	2.75
Zinc	µg/L	1	5	1.4	3.9	1.5	3.4
Number of Samples		**4**		**4**		**4**	

Source: Boggs (2001a)

3.7.2 Toxicity Testing

Ambient toxicity testing was conducted on waters collected from selected monitoring stations in 1999 and 2000. Ambient toxicity testing evaluates the survival, growth, and/or reproduction of selected test organisms exposed to water collected from the site. These characteristics are generally evaluated by placing the test organisms in a series of dilutions of the site water. The waters used were 6.25, 12.5, 25, 50 and 100 percent concentrations of the site water. Simultaneously, other organisms of the same species are placed in laboratory water for control (zero percent site water).

In 1999 and 2000, water samples from surface water monitoring stations SW01, SW05, SW08, and SW15 were tested. Testing was conducted using the *Ceriodaphnia dubia* (*C. dubia*) partial life-cycle test and the fathead minnow (*Pimephales promelas*) survival and growth test. In 2000, testing of water from monitoring station SW05 could not be completed with either test organism because there was insufficient water in the creek for sample collection. The detailed results of this testing are presented in Boggs (2001c).

The results of the ambient toxicity testing are summarized in Table 3.7-4. Except for the 1999 fathead minnow test with SW05, these results indicate that the survival, reproduction, and growth of the test organisms was the same in water from the Pogo surface water monitoring stations and the laboratory control water.

The 2000 testing for station SW08 indicated a possible observed effect to the reproduction but not the survival of the *C. dubia.* The results indicated that reproduction was statistically lower for the 25 percent strength site water only. All other dilutions, including the 50 and 100 percent site water, had reproductive rates that were not statistically different than those of the laboratory controls. These responses by the test organism are not a typical or expected. Hence, these results are inconclusive for SW08.

Table 3.7-4 Ambient Toxicity Testing Summary Results

Monitoring Station	1999 *C. dubia*		2000 *C. dubia*		1999 Fathead Minnow		2000 Fathead Minnow	
	Survival	Repro-duction	Survival	Repro-duction	Survival	Growth	Survival	Growth
SW01	NE	NE	NE	NE	NE	NE	NE	NE
SW05	NE	NE	NR	NR	EO	EO	NR	NR
SW08	NE	NE	NE	PE	NE	NE	NE	NE
SW15	NE	NE	NE	NE	NE	NE	NE	NE

NE = No effect observed
PE = Possible effect observed
EO = Effect observed
NR = Not run due to unavailability of water

Source: Boggs (2001c)

The 1999 testing for station SW05 demonstrated a negative effect to the survival and growth of the fathead minnow. The no observed effect concentration (NOEC) and the lowest observed effect concentration (LOEC) for organism survival were estimated to be less than 6.25 percent and 6.25 percent, respectively. The NOEC and the LOEC for organism growth were also estimated to be less than 6.25 percent and 6.25 percent, respectively. Compared to other monitoring stations tested, SW05 has higher concentrations of arsenic, copper, nitrate, and ammonia. One or more of these constituents may have affected the fathead minnow growth and survival.

3.7.3 Groundwater Quality

Baseline groundwater chemistry for the Pogo project site has been characterized through collection and evaluation of groundwater chemistry data from 1998 through 2001 and is ongoing in 2002 (Golder Associates and AMEC Earth & Environmental [AMEC], 2001)

The baseline chemistry of the ground water in the bedrock was assessed through collection of samples from monitoring wells located in the Pogo Ridge area. The country rock wells are located in the adit alignment and in the country rock downgradient from the ore zones. The ore zone wells are located in both the L1 and L2 ore zones. The location of these wells is shown ni Figure 3.6-1). A list of wells sampled and their location in the different areas of the site is presented in Table 3.7-5. Eleven bedrock wells were sampled: seven wells represented the ore zone ground water and four in the country rock.

The baseline chemistry of the ground water in the Goodpaster River Valley was assessed by collection of samples from monitoring wells installed in the valley, west of the exploration adit. Fourteen monitoring wells and two large-diameter wells were sampled in the valley. Four wells are located near the Goodpaster River and 12 are located closer to the valley margin. Nested monitoring wells provide information about the upper and lower valley sediment ground water. Monitoring wells MW98-010A and MW98-011A were installed in the deeper portion of the valley sediments (between approximately 50 and 80 ft deep), whereas wells MW98-010B and MW98-011B were installed in the shallow portion of the sediments (less than 40 ft deep). An additional 21 wells were drilled in the Goodpaster River Valley in the vicinity of Liese Creek. These wells were completed with depths varying from 30 to 84 feet.

Table 3.7-5 Pogo Groundwater Wells

Ridge Bedrock		Goodpaster Valley			Liese Creek
Country Rock	**Ore Zone**	**Near River**	**Valley Margins**	**Near Liese Creek**	**Bedrock**
MW99-216 MW98-080, MW98-081 MW98-082	MW97-041, MW97-071, MW97-076, MW98-133, MW99-189, MW99-202 MW99-204	MW98-004, MW98-005, MW98-006, MW99-016	INJ1 INJ2 MW98-003, MW98-009, MW98-010A MW98-010B MW98-011A MW98-011B MW98-012 MW98-013 MW98-014 MW98-015	LL-001 Through L030	MW99-213, LB-001, LB-003A, LT-003, LT-007A, LT-007B, LD-005 LT-009

Source: Golder Associates and AMEC (2001)

Most wells were sampled on multiple occasions to provide a reliable evaluation of baseline water quality. Seven groundwater sampling events were conducted from June 1998 to September 1999. The frequency of sampling in 2000 and 2001 varied across the monitoring well network. In addition, monthly sampling of ground water at wells near the injection wells (INJ1 and INJ2) was started just prior to the initiation of the injection system in August 1999 and has continued through 2000 and 2001.

Liese Creek groundwater geochemistry was assessed through monitoring wells installed in the Liese Creek Valley. Eight bedrock wells were installed.

Chemistry Summary

Three groundwater quality types have been identified within the Pogo mine site area. They are: (1) country or nonmineralized rock, (2) ore zone, and (3) valley sediments. Ground water encountered in wells located in the country rock consists of a calcium/magnesium-carbonate/ sulfate type ground water. Ground water in the ore zones has a larger proportion of sodium and is therefore a calcium/magnesium/sodium-carbonate/sulfate ground water. Ore zone L2 appears to have a more pronounced sodium signature than ground water in the L1 ore zone. Valley sediment ground water is characterized by calcium-carbonate type ground water, with some wells located closer to the country rock having a more pronounced magnesium signature, similar to that of the country rock wells.

The chemistry of each groundwater type is described in further detail below and is summarized in Table 3.7-6. For metals concentration in ground water, only dissolved metals content is discussed because it is more representative of actual aqueous phase concentrations.

Pogo Ridge Bedrock Wells

Ground Water in Country Rock

Ground water in the country rock is moderately hard to very hard (hardness range of 198 to 638 mg/L) and alkaline. Calcium and magnesium in the country rock are somewhat greater than in the valley sediments. Sulfate or bicarbonate can be the dominant anion, depending on the sample.

Concentrations of other major ions, such as sodium, are also elevated in ground water in the country rock relative to groundwater samples collected from the valley sediments near the river. Iron concentrations are at the lower end of the range observed in groundwater samples collected from the valley sediments. Heavy metals are generally present in trace concentrations. However, on occasion, more elevated concentrations are observed. Zinc concentrations in the country rock are elevated compared to those in ground water in other areas. Arsenic concentrations are generally low compared to those in ore zone wells.

Ore Zone Ground Water

Ground water from the ore zone is characterized by a larger range of hardness and TDS concentrations, but a similar pH range similar to that of ground water in the country rock. In the ore zone ground water, sodium is characteristically present in greater concentrations compared to those for the country rock.

Iron concentrations are highly variable, depending on the well, but can be quite elevated. Heavy metals are generally present in trace concentrations, but some peaks have been observed sporadically at various wells. Elevated arsenic concentrations were observed in many wells located in the ore zone, with several wells having arsenic concentrations greater than 2 mg/L. The highest concentrations detected was 5100 µg/L at well MW97-076. TDS concentrations were also elevated in the ore zone with a number of wells reporting concentrations above 900 mg/L.

Table 3.7-6 Ground Water Summary of Water Quality Ranges

	Units	Ridge Bedrock Country Rock	Ridge Bedrock Ore Zone	Goodpaster Valley Near River	Goodpaster Valley Valley Margins	Goodpaster Valley Near Liese Creek	Liese Creek Bedrock	Water Quality Standards Drinking Water MCL	Water Quality Standards Fresh Water Aquatics CCC
General Parameters									
Hardness	mg/L	427	555	122	266	59	178		None[1]
		198	<1	51	25	41	76		
		638	1330	293	560	101	356		
TDS	mg/L	550	797	176	399	90	213		
		173	128	58	88	50	99		
		744	1760	443	746	548	430		6.5 – 8.51
pH	pH units	8.1	7.9	7.1	7.0	7.2	7.7		
		7.6	7.1	6.1	5.9	6.2	6.7		
		8.4	8.5	8.5	8.0	8.1	8.3		
Alkalinity	mg/L	285	296	58	98	41	116		> 20 mg/L, as $CaCO_3$ unless naturally lower[1]
		200	60	35	15	30	62		
		374	530	110	270	71	188		
Sulfate	mg/L	199	311	63	165	23	60		250 mg/L[1]
		93	11	15	3	12	5		
		271	951	174	355	44	192		
Dissolved Metals									
Aluminum	µg/L	161	38	12	85	23	21	200	
		1	1	2.0	1	0.25	1.5		
		1840	674	53	1040	120	125		
Arsenic	µg/L	44	1619	2	43	1.8	21	50[2]	
		9.4	9	0.05	3	0.05	1		
		153	5100	6.4	145	14.2	50		
Barium	µg/L	55	32	36	86	18	19		
		14	3.3	13	21	9.3	4.0		
		491	372	104	323	33	44		
Cadmium	µg/L	0.073	0.19	0.037	0.067	0.036	0.042	5	0.7-3.0
		0.01	0.01	0.010	0.010	0.01	0.01		
		0.45	1.3	0.110	0.280	0.13	0.35		
Calcium	mg/L	80	114	34	66	17	45		
		41	19	14	7	12	21		
		105	297	83	138	29	64		
Copper	µg/L	0.95	2.7	0.98	1.1	0.76	0.85	1000	7.2 – 37.1
		0.05	0.05	0.30	0.05	0.05	0.05		
		4.2	33.6	3.1	18.3	4.5	2.1		
Iron	mg/L	0.68	1.2	0.24	12	0.045	0.052	0.3	1
		0.01	0.015	0.010	2	0.01	0.01		
		3.26	19.2	2.0	30	0.37	0.28		
Lead	µg/L	0.55	0.21	0.065	0.21	0.037	0.042		1.4 – 10.9
		0.01	0.01	0.010	0.01	0.01	0.01		
		5.35	1.94	0.49	1.9	0.4	0.17		

Dissolved Metals									
Magnesium	mg/L	54	68	9.2	24	4	14		
		23	6	3.6	2	3	5		
		77	142	23	53	8	42		
Manganese	µg/L	237	249	481	1001	158	13	50	
		65	27	0.59	76	0.025	0.025		
		911	1130	1790	4750	1100	69		
Mercury	µg/L	0.015	0.024	0.016	0.015	0.0053	0.012	2	0.012
		0.0005	0.0005	0.0005	0.001	0.0005	0.0005		
		0.05	0.1	0.050	0.050	0.05	0.05		
Nickel	µg/L	12	11	0.86	1.38	0.39	0.53	100	98.6-497
		0.3	0.3	0.05	0.05	0.05	0.05		
		116	236	5.2	7.8	3.8	1.9		
Potassium	mg/L	3.8	4.0	1.3	2.38	1.0	1.4		5
		1	1	1.00	1.00	1	1		
		6.4	13	3.4	12.00	2.8	3.5		
Selenium	µg/L	3	1.2	0.50	0.62	0.5	0.5	50	
		0.5	0.5	0.50	0.50	0.5	0.5		
		19	5	1.0	3.0	0.5	1		
Silver	µg/L	0.012	0.024	0.0090	0.012	0.006	0.008	100	0.12
		0.005	0.01	0.0050	0.005	0.005	0.005		
		0.05	0.11	0.060	0.11	0.01	0.02		
Sodium	mg/L	29	37	4.2	10	3	4		
		8	3	2.7	1	1	1		
		48	94	7.0	60	6	11		
Zinc	µg/L	66	21	2.9	7.0	0.94	2.1		66.8 – 338
		2.3	4	0.50	0.8	0.25	0.5		
		660	88	35	88	6	10.6		
Number of samples		**26**	**35**	**78**	**112**	**128**	**35**		

[1] Alaska Water Quality Criteria (18 AAC 70, September 2000) Source: Golder Associates and AMEC (2001)
[2] Arsenic drinking water standard (MCL) is scheduled to change to 10 µg/L in 2006
Concentrations for each parameter are listed in order of Mean, Minimum, and Maximum
All concentrations are in mg/L or ug/L as indicated except pH which is in Standard Units
Hardness is as CaCO3 equivalent
Alkalinity is as CaCO3 equivalent
All metals results are dissolved values
Fresh Water Aquatic CCCs that are hardness dependent are presented for a hardness range of 59 to 400 mg/L

Goodpaster River Valley

Ground Water Near Goodpaster River

Monitoring wells MW98-004, MW98-005, MW98-006, and MW99-016 are located near the Goodpaster River and have generally similar geochemical signatures (by major ions) to those of surface water samples, including samples from the Goodpaster River. Although there are some variations, with MW99-016 having higher TDS and manganese concentrations than the other wells, it appears that ground water at these wells may be recharged by the river to some degree. The pH of ground water in these wells is near neutral.

The major dissolved constituents in the ground water include calcium, magnesium, alkalinity, and sulfate. Sodium and potassium concentrations are generally low, either less than or slightly above the method reporting limit (MRL). Dissolved metals are typically present at very low concentrations.

Valley Sediments Near the Valley Margin

Monitoring wells MW98-003, MW98-009, MW98-010A/B, MW98-011A/B, MW98-012, MW98-013, MW98-14, MW98- 015, and injection wells INJ1 and INJ2 are located closer to the valley margin. The geochemical signature of these wells is generally more similar to that of the country rock wells than it is to geochemical signatures of the other wells in the valley. A few of the wells (i.e., MW98-10B [shallow well] and MW98-14) have somewhat lower concentrations of dissolved constituents even though they are closer to the valley margin than the Goodpaster River. Generally, the ground water closer to the valley margins has a higher hardness and TDS than ground water closer to the Goodpaster River. TDS values are as high as 746 mg/L. Major ion concentrations are also higher: calcium, magnesium, sodium, alkalinity, and sulfate. Dissolved metal concentrations are higher in some wells near the valley margin for the following parameters:, arsenic at well INJ2 (145 µg/L), manganese at well MW98-012 (4750 µg/L), and zinc at well MW98-015 (88 µg/L).

Monitoring wells MW98-011A and B were installed in the lower and upper portions, respectively, of the valley sediments. Analyses of samples collected from these wells indicate that the chemical composition of the ground water in both the upper and lower sediments is similar, although slightly better quality (less mineralized) water is present in the deeper zone.

The nested wells MW98-010A and B, which are located closer to the valley margin, indicate that in this area the deeper water is more similar to that of country rock (more mineralized) compared to the deeper water of the shallow zone, which is more chemically similar to near-river ground water.

The ground water from well MW98-012 shows a chemistry that is different from the groundwater chemistry from other wells located in the valley. The ground water at this location is dominated by sodium, but with amounts of sulfate, chloride, and bicarbonate that are similar to those of the ore zone ground water. Well MW98-012 is located in a permafrost area; therefore, infiltration is limited and groundwater flow at this location is likely more sluggish than at other valley locations and exhibits higher concentrations of dissolved minerals.

A comparison of major cations (calcium and magnesium) suggests that the influence of groundwater inflow from bedrock on the composition of the ground water in the valley sediments is greater, in general, near the valley margin than near the river. In these areas, a higher portion of the ground water in the valley sediments may be derived from the bedrock groundwater flow system. Lower TDS soft waters, such as those observed near the river, may be present in recharge zones where the influence of bedrock groundwater contribution to the overall flow regime is less.

Goodpaster River Valley Near Liese Creek

Ground water wells LL-001 through LL-030 were installed in the alluvial gravels of the Goodpaster River Valley in the area where the Liese Creek channel drains into the wetlands. Ground water at these locations has a chemical signature similar to that of the surface water samples and near-river monitoring wells. However, concentration ranges are wider in the Goodpaster Valley wells near Liese Creek than in the surface water and near-river monitoring wells in the area of the exploration camp. The major dissolved constituents in the ground water include calcium, magnesium, alkalinity, and sulfate. Similar to near-river ground water, chloride, sodium and potassium concentrations are uniformly low, either less than or slightly above the MRL. Dissolved metals are also present at low concentrations.

Liese Creek Bedrock

The groundwater chemistry in the wells in the Liese Creek Valley are most similar to the Goodpaster River valley wells. Hardness and TDS are low compared to those characteristics for the Pogo Ridge bedrock wells. No elevated concentrations of dissolved metals other than iron and manganese were measured in these wells.

Groundwater Quality Comparison

Goodpaster River Valley

Water quality standards for drinking water and fresh water aquatic life (chronic) are included in the groundwater chemistry (Table 3.7-6). These standards are presented for comparative purposes and do not directly apply to naturally occurring ground water. According to 18 AAC 70.235(d), natural conditions represent applicable water quality criterion.

Parameter concentrations in groundwater samples from the valley bottom sediments generally meet their respective standards for drinking water and fresh water aquatic life (chronic), except for arsenic, iron, manganese, and, in some instances, aluminum or zinc. Exceedance of the drinking water MCLs for arsenic (of 50 µg/L) occurs at wells INJ2, MW98-011A/B, MW98-010A, and MW98-015, with the highest concentration at INJ2 (145 µg/L). The arsenic concentration in the lower portion of the sediments at well MW98-010A does not meet the drinking water MCL; however, the upper portion of the sediments (MW98-010B) does. Arsenic concentrations are below the MCL both in the upper and lower portions of the sediments at wells MW98-015 (deep well) and MW98-003 (shallow well).

Dissolved iron exceeded both the secondary MCL (0.3 mg/L) and the fresh water aquatic life standards (1 mg/L), and manganese exceeded the drinking water secondary MCL (50 µg/L) at all wells in the valley bottom sediments, except wells MW98-004, MW98-005, and MW98-006. Aluminum concentrations in the ground water are above the drinking water secondary MCL (200 µg/L) for all sampling events at wells MW98-010B and MW98-012 and on one occasion at well MW98-014. Copper and lead slightly exceeded the fresh water aquatic life criteria at well MW98-012. Zinc concentrations in ground water rose slightly above the fresh water aquatic life criteria on one occasion at wells MW98-009 and MW98-015, but decreased to below the criteria on all subsequent sampling events. No other fresh water aquatic life chronic criteria or drinking water standards were exceeded for dissolved metals.

Groundwater quality from wells in the Goodpaster Valley near Liese Creek show very few exceedances. The manganese concentration at well LL-001 was considerably above the drinking water secondary MCL, whereas results at well LL-002 installed upgradient from well LL-001 does not show any exceedance. Manganese concentrations slightly above the drinking water secondary MCL were observed at LL-003 and LL-012A. A slight exceedance of the drinking water MCL was also observed for mercury during one event at LL-012B. No other exceedances were observed at these Goodpaster Valley wells.

Bedrock Near Pogo Ridge

The bedrock ground water wells have a larger number of parameters that exceed the applicable standards. Arsenic, iron, and manganese exceed standards at most wells, while exceedances of aluminum, antimony, cadmium, copper, mercury, nickel, selenium, and zinc were also observed. The highest arsenic concentration in ground water (5.1 mg/L) is observed at well MW97-076, installed across the L1 ore zone. Arsenic concentrations are also above the drinking water MCL in ground water sampled from wells MW97-071, MW97-076, MW98-081, MW98-133, MW99-189, MW99-202, and MW99-204. Bedrock groundwater concentrations of manganese at all wells in the ridge, with the exception of well MW99-202, were greater than the drinking water secondary MCL. Iron concentrations also were above the drinking water secondary MCL. Iron concentrations also were above the fresh water aquatic life chronic criterion at most wells, except wells MW98-080, MW99-189, and MW99-202.

Zinc was above the fresh water aquatic life chronic criteria on two occasions at wells MW98-081, MW98-082, and MW99-204. Exceedances of the applicable standards were observed during one sampling event for aluminum (at wells MW99-204, MW99- 216, MW98-081, and MW98-082) and during some sampling events for copper (well MW99- 204), nickel (wells MW97-076 and MW98-080), mercury (well MW99-133), cadmium (wells MW97-076 and MW97-071), and lead (well MW99-204).

Liese Creek Bedrock

Groundwater quality from wells installed near Liese Creek show very few exceedances. The manganese concentration at well MW99-213 was slightly above the secondary MCL. No other exceedances were observed at the Liese Creek Valley wells.

3.8 Air Quality

3.8.1 Site Meteorology

The Applicant installed a prevention of significant deterioration (PSD) quality meteorological monitoring station near the mine site. Data has been collected from September 1998 to the present. Temperature, wind speed, wind direction, relative humidity, and total precipitation have been recorded at the station. Recorded temperatures in 1999 ranged from a high of 79°F to a low of –34°F, with summer average temperatures of approximately 55°F and winter average temperatures of approximately –20°F (Hoefler Consulting Group, 2001). These temperatures compare favorably with long-term averages reported at the Big Delta station.

Other data recorded at the PSD station for 1999 included a maximum wind speed of 13.2 meters per second, average wind speed of 2.6 meters per second, and average relative humidity of 65.4 percent (Hoefler Consulting Group, 2001). These results are very typical of the climate in interior Alaska.

3.8.2 Air Quality

Air quality is regulated through ambient air quality standards and enforcement of emission limits for individual sources of air pollution. The federal Clean Air Act required the EPA to identify National Ambient Air Quality Standards (NAAQS) to protect public health and welfare. These standards are presented in Table 3.8-1. The State of Alaska has adopted the federal NAAQS.

An area is classified as an attainment area if it meets the NAAQS standards, as a non-attainment area if it does not meet the standards, or as unclassifiable on the basis of available data [Clean Air Act, 107(d)(1)(A)(i-iii)]. Because no air pollutant data has been collected in the project area, it is considered unclassifiable. However, because the nearest road is approximately 36 miles away and the nearest point sources or pollutants are more than 40 miles away, it can be deduced that the area is presently meeting the NAAQS. Ability to meet NAAQS also can be demonstrated by comparing the project area to Fairbanks, which is the closest area that measures air pollutants.

Air pollutant data for the Fairbanks area indicates compliance with all NAAQS except for carbon monoxide (CO). High ambient levels of CO in the Fairbanks area are a result of vehicle travel that does not occur in the project area. Recognizing that the project area is away from any populated or industrial area, it can be concluded that ambient air quality in the project area is better than that measured in Fairbanks and is therefore in compliance with the NAAQS.

Table 3.8-1 National and State of Alaska Ambient Air Quality Standards

Pollutant	Averaging Time	Primary (Health)	Secondary (Welfare)
Particulate matter less than 2.5 µm diameter (PM2.5)	Annual arithmetic mean	15.0 µg/m^3	15.0 µg/m^3
	24 hours	65 µg/m^3	65 µg/m^3
Particulate matter less than 10 µm diameter (PM10)	Annual arithmetic mean	50 µg/m^3	50 µg/m^3
	24 hours	150 µg/m^3 [c]	150 µg/m^3 [c]
Ozone (O3)	1 hour	0.12 ppm [c]	0.12 ppm [c]
Carbon monoxide (CO)	8 hours	9 ppm [b]	N/A
	1 hour	35 ppm [b]	N/A
Sulfur dioxide (SO2)	Annual arithmetic mean	0.030 ppm [a]	N/A
	24 hours	0.14 ppm [b]	N/A
	3 hours	N/A	0.5 ppm [b]
Nitrogen dioxide (NO2)	Annual arithmetic mean	0.053 ppm	0.053 ppm
Lead (Pb)	Calendar quarter average	1.5 µg/m^3	1.5 µg/m^3

[a] Not to be exceeded.
[b] Not to be exceeded more than once per calendar year.
[c] Not to be exceeded more than one day per calendar year.

Source: 40 CFR 50.4-50.12

The Pogo Mine site is considered a PSD Class II area, and is over 200 kilometers from a PSD Class I area.

Existing sources of air pollutant emissions in the general area are minor (do not require an air quality permit), dispersed, and away from the project site. The Richardson Highway passes approximately 30 miles southwest and Big Delta and Delta Junction are approximately 32 miles and 38 miles southwest of the project site, respectively. Vehicular traffic in these areas primarily releases carbon monoxide (CO), but also contributes lesser amounts of unburned hydrocarbons, particulate matter, and oxides of nitrogen. These same compounds also are released from wood stoves in Big Delta and Delta Junction as well as from more remote cabins scattered in the general area. Even under the worst-case meteorological condition, measurable amounts of the pollutants from vehicular traffic and wood stoves would not be expected to be seen at the project site due to the relatively small quantities released at a great distance from the site. There are no other sources of air pollutants in the area that have a potential to impact the project site.

3.9 Noise

This section provides details on noise levels, noise regulations, project impact criteria, area land use survey, and ambient noise level projections. An introduction to acoustics and noise level descriptors is included for reference and to assist in understanding noise data and impact analysis.

3.9.1 Introduction to Acoustics

Human response to noise is subjective and can vary greatly from person to person. Factors that can influence individual response include the loudness, frequency, amount of background noise present before an intruding noise, and the nature of the work or activity (e.g., sleeping) that the noise affects.

The unit used to measure the loudness of noise is the decibel (dB). To better approximate the sensitivity of the human ear to sounds of different frequencies, the A-weighted decibel scale was developed. Because the human ear is less sensitive to higher and lower frequencies, the A-weighted scale reduces the sound level contributions of these frequencies. When the A-weighted scale is used, the decibel levels are denoted as dBA.

A 10-dBA change in noise levels is judged by most people as a doubling of sound level. The smallest change in noise level that a human ear can perceive is about 3 dBA, and increases of 5 dBA or more usually are noticeable. Normal conversation ranges between 44 and 65 dBA when speakers are 3 ft to 6 ft apart.

Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful, while levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises.

Several factors determine how sound levels reduce over distance. Under ideal conditions, a point noise source in free space will attenuate at a rate of 6 dB per doubling of distance (using the inverse square law). An ideal line source (such as constant flowing traffic on a busy highway) reduces at a rate of approximately 4.5 dB per doubling of distance. Under normal conditions however, noise sources are usually some combination of the two examples, resulting in sound attenuation that lies somewhere between the two *ideal* reduction factors. Other factors that affect the attenuation of sound with distance include existing structures, topography, foliage, ground cover, and atmospheric conditions such as wind, temperature, and relative humidity. More detailed information on acoustics and sound transmission is contained in Appendix A-2.

3.9.2 Noise Level Descriptors

Noise levels used in this analysis for mining operations and other project-related noise sources (with the exception of blast noise) are stated as sound pressure levels in terms of decibels on the A-scale (dBA). The A-scale is used in most ordinances and standards, including the applicable standards selected for this project. To account for the time-varying nature of noise, several noise metrics are useful. The equivalent sound pressure level (L_{eq}) is defined as the average noise level, on an energy basis, for a stated time period (for example, hourly).

Other commonly used noise descriptors include the L_{max}, L_{min}, and L_n. The L_{max} and L_{min} are the greatest and smallest root-mean square sound levels, in dBA, measured during a specified measurement period. The sound level descriptor L_n is defined as the sound level exceeded “n” percent of the time. For example, the L_{25} is the sound level exceeded 25 percent of the time; therefore, during a 1-hour measurement, an L_{25} of 60 dBA means the sound level equaled or exceeded 60 dBA for 15 minutes during that hour.

For reference, Table 3.9-1 shows sound levels for some common noise sources and compares their relative loudness to that of an 80-dBA source such as a garbage disposal or food blender.

3.9.3 Noise and Vibration Criteria

This subsection describes the noise standards and regulations used for evaluation of potential impacts associated with the Pogo Mine project. Several regulations and ordinances were examined and used to derive the project impact criteria. Sources included the Federal Highway Administration (FHWA), EPA, the U.S. Bureau of Mines (BOM), and the US Department of Transportation (USDOT). Details and general information on the individual noise and vibration criteria are contained in Appendix A.2.

The severity of noise impacts will be determined by the project-related increase over the existing average ambient noise level and the project-related energy average hourly noise level (L_{eq}), at each representative receiver location. As previously stated, human sensitivity to changes in noise levels will vary depending on certain conditions. Normally, the smallest change in ambient (broadband) noise levels that a human ear can perceive is approximately 3 dBA. Increases of 5 to 7 dBA are usually noticeable to most people, and a 10-dBA change is judged by most people as a doubling of the sound level. Given this information, the measured existing noise levels, and information from the EPA and BOM, the impact criteria used to determine significance for the Pogo project are given in Table 3.9-2.

In addition to the criteria given in Table 3.9-2, noise-sensitive receivers along haul routes that exceed the FHWA residential impact criteria of 67 dBA were considered to have a high traffic noise impact. Details on the traffic noise criteria are given in Appendix A-2.

There are no existing vibration criteria applicable to the proposed project. Estimates of expected vibration levels are used because vibration readings are dependent on the source of vibration, the transmitting medium, and distance from the vibration source. For the purpose of this analysis, vibration impacts included those that may interrupt normal living or working conditions at sensitive receptors located close to the facility and those that may cause structural damage to nearby buildings or environment. Table 3.9-3 contains the criteria used to evaluate potential vibration impacts.

3.9.4 Project Area Land Use

Land use within a 50-mile radius of the Pogo Mine site was investigated for land use sensitivity to noise and vibration. The large 50-mile radius was used to include access route options to the proposed mine location. Land use in the study area includes residential, commercial, light and heavy industrial, and undeveloped lands. The majority of residential land use in the study area occurs near the Richardson Highway, between Big Delta and Delta Junction, with several residential uses along Shaw Creek Road. Other noise-sensitive land uses include numerous cabins near the Goodpaster Winter Road and in the vicinity of Quartz Lake, and multiple recreational areas located throughout the project area.

Table 3.9-1 Sound Levels and Relative Loudness of Typical Noise Sources Found in Indoor and Outdoor Environments

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage, Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), pneumatic drill (50 ft)	80	Moderately loud	Reference loudness
Vacuum cleaner (10 ft) Passenger car at 65 mph (25 ft)	70		1/2 as loud
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room, bird calls	40	Moderately quiet	1/16 as loud
Typical wilderness areas	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and EPA (1971a)

Table 3.9-2 Levels of Noise Impacts

Low Impact	Moderate Impact	High Impact
No noise-sensitive sites are located in the project area, or the increase in noise levels with project implementation is projected to be less than 5 dBA at noise-sensitive sites and the overall project related hourly average noise level does not exceed 50 dBA L_{eq}.	Increases in noise levels with project implementation are expected to be between 5 dBA and 10 dBA, and the overall project-related hourly average noise level does not exceed 50 dBA L_{eq}. Determination of level of impact considers existing noise levels and the presence of noise-sensitive sites.	Project activity would cause an increase in existing noise levels of 10 or more dBA, and overall project-related hourly average noise levels exceed 50 dBA L_{eq}. Determination of level of impact considers existing noise levels and the presence of noise-sensitive sites.

Table 3.9-3 Levels of Vibration Impacts

Low Impact	Moderate Impact	High Impact
No vibration-sensitive sites are located in the project area, or the increase in vibration levels with implementation of the project remains at or below 0.5 in./sec at vibration-sensitive sites.	Increases in vibration levels during blasting are between 0.5 in./sec and 2.0 in./sec. Determination of significance also will consider existing noise levels and the presence of noise-sensitive sites.	Proposed project would cause an increase in the vibration levels during blasting of 2.0 in./sec or greater.

3.9.5 Ambient Noise Levels

Ambient noise levels in the project area were projected for areas with noise sensitivity using measured noise data from similar areas. The measured data was taken from the Ft. Knox and True North mine projects at several locations near Cleary Summit and the Olnes Subdivision, northeast of Fairbanks (CH2M Hill, 1993; Minor & Associates, 2000). The Ryan Lode data was measured near the town of Ester, just west of Fairbanks (Minor & Associates, 1998). In addition, traffic volume information from ADOT/PF was used to project traffic noise levels in the existing noise environment. Finally, information contained in EPA guidance (1971b) was used to verify the projected ambient noise levels.

For the purpose of describing the existing ambient noise environment, several areas with noise sensitivity that could be affected by the project were identified. For each of the identified areas, ambient noise levels were projected. The noise sensitive areas were:

- Shaw Creek Road, Shaw Creek Lodge, and vicinity
- Big Delta and vicinity
- Quartz Lake Recreational area and vicinity
- Delta Junction and vicinity
- Goodpaster Winter Trail to Goodpaster River Crossing and vicinity
- Goodpaster River between Pogo and Liese creeks at the mine site
- Richardson Highway for areas not covered above

For each of these areas, noise levels and existing noise sources were identified from on-site inspections, land use information, and a general understanding of the activities in the given areas. Major noise sources common to most areas include local fixed-wing aircraft and helicopter overflights, existing mining and exploration operations, local area snow machines and ATVs (both recreational and local access use), aircraft overflights from US Air Force training missions, and heavy truck traffic on the Richardson Highway.

Noise levels from these sources can vary greatly, depending on the location of the receiver relative to the noise source. For example, maximum pass-by noise levels from heavy trucks along the Richardson Highway could reach 86 dBA at 50 ft from the highway. Noise levels at residences, however, will vary depending on their proximity to the highway and the level of shielding, if any, between the highway and the residence. Maximum fly-over noise levels from aircraft and helicopters, which will continue to be the highest instantaneous noise source, can vary from 106 to 131 dBA L_{max} at 100 ft above ground level. It should be noted, however, that the maximum noise levels only occur for a short time, and therefore raise the average ambient hourly L_{eq} very minimally.

Other noise sources include passenger vehicle traffic and miscellaneous residential, recreational and commercial activities, including chain saws, generators, and occasional small weapons firing. Noise related to ongoing mining exploration and other industrial activities is also expected to be noticeable in some locations. Other less noticeable sources include wind; wildlife, such as birds; and water noise near moving creeks and rivers. The following sections provide details on the projected ambient noise levels and existing noise sources.

Shaw Creek and Vicinity

Noise levels during summer months are dominated by traffic noise from the Richardson Highway, local access traffic, and occasional aircraft overflights. Other noise sources include residential and recreational activities. During winter months, major noise sources also include a significant level of snow machine activity. Noise levels during summer are projected to range from 32 to 50 dBA L_{eq}. Winter noise levels are projected at 27 to 40 dBA L_{eq}. Table 3.9-4 contains the range of noise levels projected for this area during summer and winter months for daytime and nighttime hours.

Table 3.9-4 Ambient Noise Levels for Shaw Creek and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	32-35	37-40	27-31	31-35
Summer Months[3]	35-37	45-50	32-35	37-40

1 Data derived from on-site noise monitoring in the Olnes Subdivision and similar areas and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Quartz Lake and Vicinity

Quartz Lake is located approximately 3 miles from the Richardson Highway. Major noise sources in the area include recreational activities and aircraft. ATVs and snow machines also are expected in this area as part of general recreation and mine exploration. Highway noise may be audible at times, depending on the location and level of traffic. Noise levels are projected to be highest in the southwestern sections of the lake due to noise from the Richardson Highway. Ambient noise levels are projected at 29 to 45 dBA L_{eq} on the side of the lake closest to the highway, and 27 to 43 dBA on the side of the lake away from the highway. Table 3.9-5 provides a summary of projected ambient noise levels for the Quartz Lake area.

Table 3.9-5 Ambient Noise Levels for Quartz Lake and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Southern Area	Northern Area	Southern Area	Northern Area
Winter Months[3]	35-38	32-35	29-32	27-31
Summer Months[3]	42-45	40-43	35-37	32-35

1 Data derived from on-site noise monitoring near Chena Hot Springs, in the Olnes Subdivision and similar areas, and from the EPA (1971a).
2 Daytime is defined as 7am to 10pm, and nighttime as 10pm to 7am.
3 For the analysis, summer is April through August, and winter is September through May.

Big Delta and Vicinity

Big Delta is located on the Richardson Highways, and traffic noise from the highway is expected to be the dominant noise source in the area. Other noise sources include local access traffic, some commercial and residential activities, and aircraft overflights. Winter noise levels are projected to range from 33 dBA L_{eq} in rural areas, to 51 dBA L_{eq} for structures located near the Richardson Highway. Noise levels during the summer months are projected at 35 to 55 dBA L_{eq}. Table 3.9-6 contains an ambient noise summary for the Big Delta and surrounding area.

Table 3.9-6 Ambient Noise Levels for Big Delta and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	41-43	46-51	33-35	40-45
Summer Months[3]	45-47	50-55	35-37	42-47

[1] Data derived from on-site noise monitoring in the community of Ester and from the EPA (1971a).
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Delta Junction and Vicinity

Delta Junction is located at the junction of the Richardson and Alaska highways. Major noise sources near Delta Junction include traffic on the Richardson and Alaska highways, aircraft from Allen Air Force Base and the local airport, and commercial, industrial, and residential activities. Structures located near the main highways are projected to have noise levels ranging from 48 to 61 dBA L_{eq}. For structures located in rural areas, away from the highways, noise levels are projected at 32 to 45 dBA. Table 3.9-7 provides a summary of projected ambient noise levels for the Delta Junction area.

Table 3.9-7 Ambient Noise Levels for Delta Junction and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Rural Area	Near Highway	Rural Area	Near Highway
Winter Months[3]	39-43	53-57	32-37	48-53
Summer Months[3]	42-45	56-61	35-40	50-55

[1] Data derived from on-site noise monitoring in Ester, northern Fairbanks, and from the EPA (1971a).
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Goodpaster Winter Trail

Main noise sources include recreational activities, including some motorized vehicles, such as ATVs and outboard motors in the summer and snow machines in the winter. Winter noise levels are projected to range from 27 to 35 dBA L_{eq}, with summer months ranging from 30 to 37 dBA L_{eq}. Table 3.9-8 provides a summary of expected maximum and minimum noise levels for the summer and winter months.

Table 3.9-8 Ambient Noise Levels for Goodpaster Winter Road and Vicinity[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Min	Max	Min	Max
Winter Months[3]	30	33	27	35
Summer Months[3]	32	37	30	37

[1] Data derived from on-site noise monitoring in the Olnes Subdivision and the Ft. Knox area before the mine was constructed and information from the EPA (1971a)
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Goodpaster River (near Pogo Creek)

The sound levels of the main noise sources for the Goodpaster River between Pogo and Liese creeks near the proposed Pogo Mine site are low, particularly during summer. They consist of recreational activities, including some motorized vehicles such as ATVs and outboard motors in the summer and snow machines in the winter. Winter noise levels are expected to be similar to those for the Goodpaster Winter Road, and are projected to range from 27 to 35 dBA L_{eq}. Noise levels in the summer months are projected to range from 32 to 42 dBA L_{eq} due to increased recreational activity and noise related to the river. Table 3.9-9 provides a summary of expected maximum and minimum noise levels for the summer and winter months.

Table 3.9-9 Ambient Noise Levels for Goodpaster River near Pogo Creek[1]

Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	Min	Max	Min	Max
Winter Months[3]	30	33	27	35
Summer Months[3]	34	42	32	39

[1] Data derived from on-site noise monitoring in the Olnes Subdivision and the Ft Knox area before the mine was constructed and information from the EPA (1971a).
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

Richardson Highway (General Area within 300 feet)

For those areas not covered above and located close to the Richardson Highway, additional noise level projections were preformed. The noise levels presented in Table 3.9-10 are for structures located within 300 ft of the Richardson Highway. This area includes any residents or other land uses between Big Gulch and Delta Junction and locations north of Big Delta. Noise levels are presented for structures located less than 150 ft and between 150 and 300 ft from the Highway. Actual noise levels will depend on the topography and shielding between the roadway and receiver location.

Table 3.9-10 Richardson Highway Ambient Noise Levels for Shaw Creek Vicinity[1]

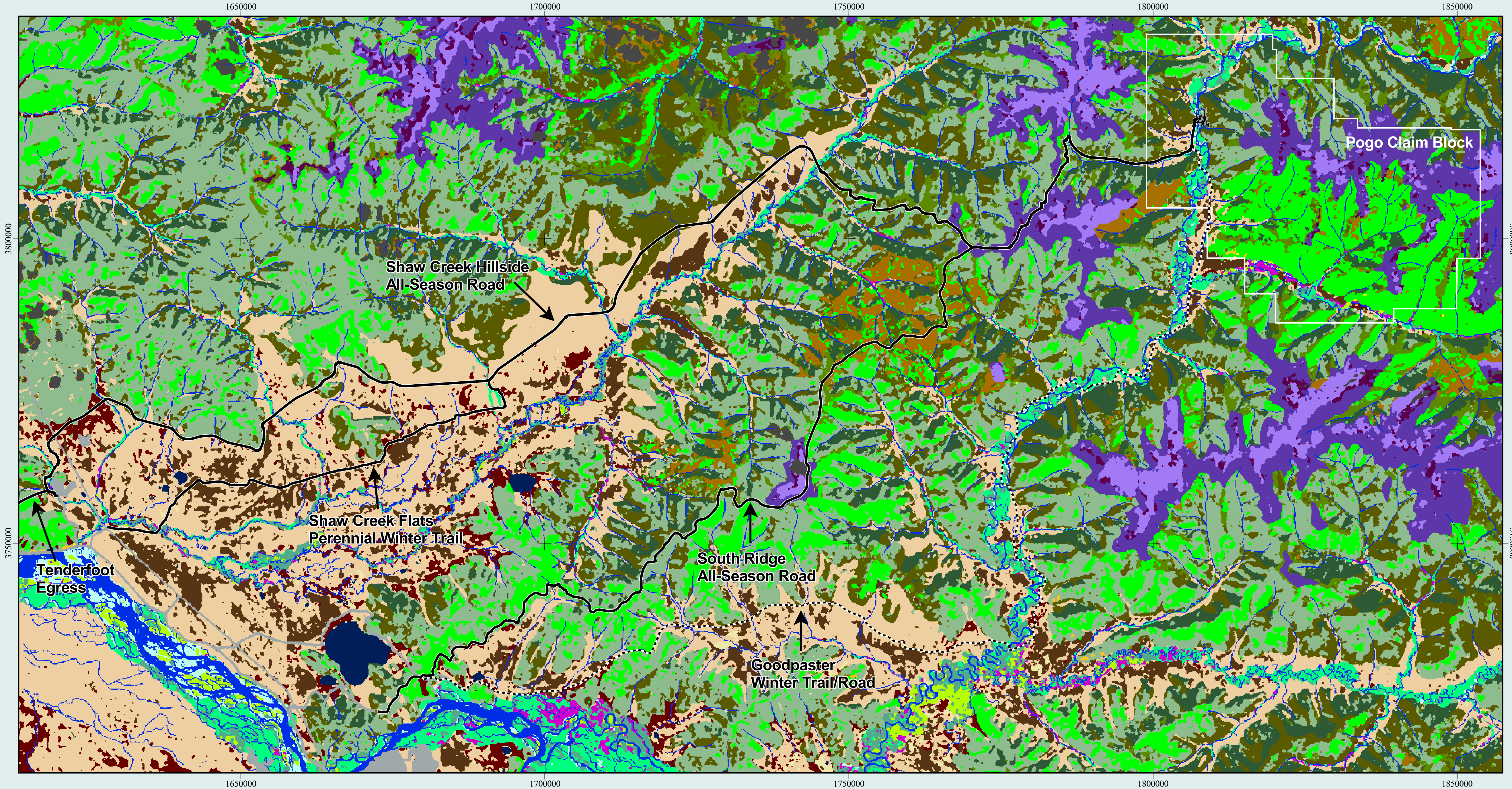
Season	Daytime[2] —Hourly L_{eq}		Nighttime[2] —Hourly L_{eq}	
	50 to 150 ft	150 to 300 ft	50 to 150ft	150 to 300 ft
Winter Months[3]	56-61	49-56	45-50	38-45
Summer Months[3]	58-63	51-58	47-52	40-47

[1] Data derived from on-site noise monitoring along the Richardson, Elliot, and Steese highways.
[2] Daytime is defined as 7am to 10pm, and nighttime is defined as 10pm to 7am.
[3] For the analysis, summer is April through August, and winter is September through May.

3.10 Vegetation

Vegetation in the overall project area was mapped for purposes of identifying wildlife habitats (ABR, 2000). This habitat classification incorporated physiographic characteristics (riverine, lowland, upland, subalpine, alpine) and vegetation types. Figure 3.10-1 shows wildlife habitats, including vegetation types, throughout the project area. Table 3.10-1 describes the habitat types and shows their percentage cover in the project area.

Vegetation has been mapped in more detail, using a somewhat different system, in most of the Pogo claim area and along access corridors (Three Parameters Plus, 2000a, 2000b; ABR, 2001). These maps may be viewed on the EIS project web site (www.pogomineeis.com). The most abundant habitats in the project area are needleleaf forests, broadleaf forests, mixed broad- and needleleaf forests, and shrub thickets dominated by scrub-form birch (*Betula glandulosa*, or hybrids of *B. glandulosa* and *B. papyrifera*) (Three Parameters Plus, 2000b; ABR, 2001). Vegetation in the project area is highly influenced by wildfire, with tall broadleaf shrub and broadleaf forest communities representing early and mid-successional stages after fire (ABR, 2000).



Wildlife Habitat Classes

- Alpine Meadow
- Alpine Dwarf Scrub
- Subalpine Needleleaf Woodland
- Cliff
- Bluff Meadow
- Upland Tall Scrub
- Upland Needleleaf Woodland
- Upland Broadleaf Forest
- Upland Mixed Forest
- Upland Needleleaf Forest
- Upland North-facing Needleleaf Forest
- Lowland Meadow
- Lowland Low Scrub
- Lowland Broadleaf Forest
- Lowland Needleleaf Forest
- Lakes and Ponds
- Riverine Barrens
- Riverine Scrub
- Riverine Broadleaf Forest
- Riverine Mixed Forest
- Riverine Needleleaf Forest
- Rivers and Streams
- Cloud and Shadow
- Human Modified

N W E S

2 0 2 4 6 8 Km
1 0 1 2 3 4 5 Mi

Supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.10-1
Project Area Vegetation/
Wildlife Habitat Classes

ABR inc. environmental research & services

25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Alpine Meadow	Wet to moist alpine areas on flats and gentle slopes dominated by sedges with an understory of dwarf or low shrubs. Organic accumulation generally is thin and rock is close to the surface. Vegetation is dominated by sedges (*Carex bigelowii, C. aquatilis*) and shrubs (*Dryas octopetala, Vaccinium uliginosum, Salix reticulata, S. planifolia, Arctostaphylos alpina*).
Alpine Dwarf Scrub	Dry, excessively drained, rocky soils above treeline on weathered bedrock dominated by dwarf shrubs. Permafrost is common at high elevations and north-facing slopes. Vegetation is dominated by dwarf shrubs (*Dryas octopetala, Salix arctica, Arctostaphylos alpina*) and includes sedges (*Carex bigelowii*), numerous forbs, and abundant lichens (*Cladina* spp.). Class includes alpine rocky barrens and partially vegetated areas.
Subalpine Needleleaf Woodland	Alpine to subalpine areas in the vicinity of treeline with a canopy composed of low and tall shrubs and scattered trees. Moist, rocky soils have thin to moderately thick organic horizons, are excessively to well-drained, and are associated with weathered bedrock. Permafrost status is uncertain. Vegetation is dominated by shrubs (*Alnus crispa*, *Betula nana, Salix planifolia, Ledum decumbens, L. groenlandicum, Vaccinium uliginosum, V. vitis-idaea*), sedges (*Carex bigelowii*), and mosses (*Hylocomium splendens, Aulacomnium turgidum*). The scattered spruce (*Picea glauca* and *P. mariana)* often are stunted.
Cliff	Partially vegetated or barren, steep, rocky outcrops. Cliffs are found along river valleys and very steep upper slopes. Isolated outcrops and tors also are included in this class.
Bluff Meadow	Dry, steep, south-facing bluffs that support grasses, forbs, and shrubs. Soils generally have a high fraction of angular fractured bedrock, although some have a moderate accumulation of loess. Drainage is good to excessive, and permafrost is absent. Common species include woody plants (*Artemisia frigida, Juniperus communis, Populus tremuloides),* grasses *(Elymus innovatus, Calamagrostis purpurascens)*, mosses *(Rhytidium rugosum)*, and lichens.
Upland Tall Scrub	Early successional upland areas with vegetation dominated by tall shrubs and broadleaf saplings. Moist, rocky to loamy soils are well-drained, have very thin organic horizons, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. This post-burn stage is dominated by *Betula papyrifera* or *P. tremuloides* saplings and *Alnus crispa* or *Salix* spp. shrub thickets Other plants include grasses (*Calamagrostis canadensis)*, forbs (*Epilobium angustifolium)*, and the moss *Polytrichum juniperinum*.
Upland Needleleaf Woodland	Upland areas on slopes and plateaus underlain by loess and thin residual soils. Vegetation is dominated by low and tall shrubs with scattered mature trees. Permafrost status is uncertain. Common shrub species include *Betula nana, Alnus crispa, Vaccinium uliginosum, Ledum groenlandicum*, and *V. vitis-idaea*. Trees present include *Picea glauca* and *P. mariana*.
Upland Broadleaf Forest	Moist, well-drained, unfrozen sites with thin to moderate loess deposits on upland slopes. The open to closed forest canopy has *Betula papyrifera* or *Populus tremuloides,* young spruce trees *(Picea glauca, P. marina),* and shrubs *(Alnus crispa, Viburnum edule, Rosa acicularis, Empetrum nigrum)* and grasses (*Calamagrostis canadensis*) in the understory. Trees can vary from small saplings to old, mature trees.
Upland Mixed Forest	Moist, well-drained soils on upland loess, dunes, and residual soil deposits that support an overstory dominated by a mixture of broadleaf and needleleaf trees. Permafrost may be present on north-facing slopes. Dominant species include *Picea glauca*, *P. mariana*, *Betula papyrifera*, *Populus tremuloides, Alnus crispa, Cornus canadensis, Geocaulon lividum, Linnaea borealis,* and *Vaccinium vitis-idaea*.
Upland Needleleaf Forest	Well-drained upland forests dominated by an open canopy of *Picea glauca* or *P. mariana,* ericaceous shrubs, and the moss *Hylocomium splendens*. Soils are unfrozen, have shallow organic horizons, and occur on residual soils and loess. Common understory species include *Alnus crispa, Betula nana, Ledum groenlandicum, Vaccinium uliginosum,* and *Geocaulon lividum*.

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Upland North-facing Needleleaf Forest	Steep north-facing slopes with needleleaf forests. Soils vary from unfrozen, well-drained, moist rocky soils to frozen, wet, thick organic soils. The open to closed tree canopy is dominated by *Picea mariana,* and the understory includes *Salix planifolia*, *Betula nana, Rubus chamaemorus, Hylocomium splendens, Sphagnum* spp., and *Pleurozium schreberi*.
Lowland Meadow	Depressions and pond margins on lowland flats dominated by sedges and grasses. Organic layer is thin to thick and is underlain by lowland loess or riverine silts. Included in this class are in-filling or drained ponds, pond edges, abandoned river channels, and shrub-poor sedge–moss bogs. Dominant species in wetter sites include *Carex aquatilis, C. rostrata, Eriophorum angustifolium, Typha latifolia,* and *Scirpus validus; Sphagnum* mosses are common in bog sites. Moist sites generally are dominated by *Calamagrostis canadensis*.
Lowland Low Scrub	Lowland areas with vegetation dominated by low shrubs. Wet, loamy to organic soils are poorly drained and underlain by permafrost. The open to closed canopy of low shrubs is dominated by *Betula nana*, ericaceous shrubs (*Ledum groenlandicum, Vaccinium uliginosum, V. vitis-idaea, Chamaedaphne calyculata*), and up to 25% *Picea mariana* or *Larix laricina* (larch). Tussocks (*Eriophorum vaginatum*) may be common. Other plants include *Salix planifolia, Rubus chamaemorus, Hylocomium splendens*, and *Sphagnum* spp.
Lowland Broadleaf Forest	Lowland areas dominated by broadleaf trees. Moist to wet, loamy to organic soils are somewhat poorly drained, have moderately thick to very thick organic horizons, and are underlain by permafrost. The open to closed overstory is dominated by *Betula papyrifera*, although *Picea glauca* and *P. mariana* often are present in the understory. Other plants include *Alnus* spp., *Rosa acicularis*, *Calamagrostis canadensis*, and *Equisetum arvense.* Lowland tall shrub communities, dominated by open to closed thickets of *Alnus* or *Salix* spp. are included in this class.
Lowland Needleleaf Forest	Lowland areas dominated by needleleaf forest. Soils are sandy–loamy to organic, usually frozen, and commonly found on bogs, abandoned floodplains, and gentle slopes. The open to closed forest canopy is dominated by *Picea marina.* Wet, organic sites have ericaceous shrubs (*Salix planifolia*, *Betula nana, Rubus chamaemorus, Hylocomium splendens, Sphagnum* spp., and *Pleurozium schreberi)*. Better drained, sandy sites have *Ledum groenlandicum, Vaccinium vitis-idaea, Pentaphylloides floribunda,* and *Hylocomium splendens.* Lowland mixed forest is included in this class, and the canopy includes more *Betula papyrifera*.
Lakes and Ponds	Lacustrine water bodies with or without emergent or floating vegetation. Lakes are found associated with thaw basins and depressions underlain by bedrock. Common plants include *Potamogeton alpinus, P. foliosus, P. gramineus, Nuphar polysepalum,* and *Isoëtes muricata.*
Riverine Barrens	Unvegetated or partially vegetated (<30% cover) river bars that are flooded frequently. Colonizing species include *Salix alaxensis*, *S. interior*, and *Equisetum arvense*.
Riverine Scrub	Early successional communities on well-drained, gravelly soils on active or inactive floodplains. Common plants are low and tall shrubs *(Salix alaxensis, S. arbusculoides, S. bebbiana, S. planifolia, Alnus tenuifolia),* balsam poplar (*Populus balsamifera),* saplings, and forbs (*E. arvense*) and grasses (*Calamagrostis canadensis*).
Riverine Broadleaf Forest	Riverine areas with moist, loamy to gravelly soils and vegetation dominated by broadleaf trees. Canopy is composed of open to closed *Populus balsamifera* or *Betula papyrifera* forests with *Picea glauca, Alnus tenuifolia, Calamagrostis canadensis, Fragaria virginiana,* and *Equisetum arvense* in the understory.
Riverine Mixed Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf and broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment The forest has a closed canopy of *Picea glauca* and *Populus balsamifera*, although *P. glauca–Betula papyrifera* stands also occur. The understory is a mixture of species found in broadleaf and needleleaf riverine forests.

Table 3.10-1 Descriptions of Project Area Habitat Classes

Ecotype Class	Description
Riverine Needleleaf Forest	*Picea glauca* forests on inactive floodplains. Soils are well- to excessively drained with thin organic horizons over interbedded silt and sands and river gravels. Associated species include *Rosa acicularis, Cornus canadensis, Geocaulon lividum, Rhytidiadelphus triquetrus,* and *Hylocomium splendens.*
Rivers and Streams	Glacial and nonglacial rivers that include headwater, braided, and meandering morphologies. In larger rivers, water flows throughout the year in deep channels.
Cloud and Shadow	Areas obscured by clouds and shadow and thus have not been assigned a habitat class. This class includes a small area of steep north-facing slope.
Human Modified	Vegetated and barren areas that have been cleared for human use. Modification includes agriculture, groups of structures, transportation ROWs, and nonvegetated clearings

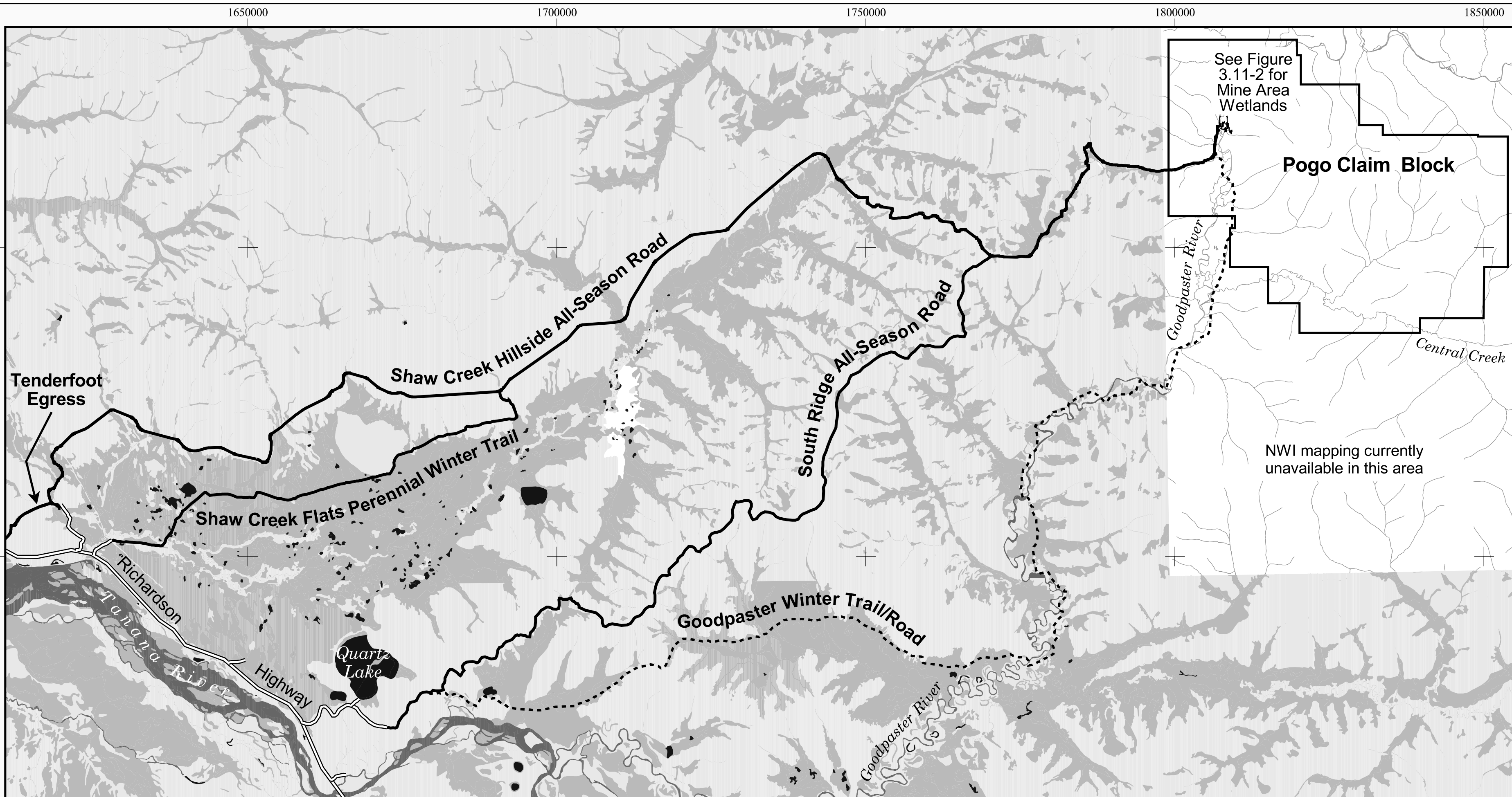
3.11 Wetlands

Wetlands are defined as, "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions..." [33 CFR 328.3(b)]. It is important to note that the wetland sections of this document focus only on wetlands and not all other waters such as ponds, lakes, and rivers. While those other waters are occasionally referenced in the wetland sections to aid federal agencies in considering areas under their jurisdiction, readers should refer to the surface water hydrology section for details. Discussion of wetlands is necessarily multidisciplinary. More detailed discussions of many aspects of wetlands can be found in other sections in this EIS that address hydrology, water quality, biological resources, and human uses of the land.

3.11.1 Wetland Extent and Locations

Detailed wetland mapping has been prepared for part of the Pogo claim block, the two all-season road option corridors, and the Shaw Creek winter road corridor (Three Parameters Plus, 2000a; 2000b; 2001b; 2002b, c, d, e). Some maps may be viewed on the project web site (pogomineeis.com), and more detailed maps may be viewed at the ADNR office in Fairbanks, the COE office in Anchorage, and the Teck-Pogo Inc. office in Fairbanks. Figure 3.11-1 shows a general map of wetlands in the vicinity of the access corridors southwest of the proposed mine site. Figure 3.11-2 shows locations of wetlands in the vicinity of the proposed mine site. The area shown in this figure represents approximately the north half of the Pogo claim block for which wetland mapping was completed.

The detailed mapping of the claim block and all-season access corridors shows that wetlands are widespread in the project area. Many occur in intricate mosaics with uplands. Wetlands predominate on lowlands adjacent to and on the historical floodplain of the Goodpaster River, on foot slopes, valley bottoms, north-facing slopes and bowls, lower parts of watersheds, abandoned channels and oxbows of the Goodpaster River, and some high-elevation plateaus.



Legend

Wetland Type:

(polygons from USFWS 1:63,360 NWI mapping)

- River
- Lake/Pond
- Wetland
- Upland
- Unknown

Stream (from USGS 1:63,360 DLG)

N W E S

2 0 2 4 6 8 10 Kilometers

1 0 1 2 3 4 5 6 Miles

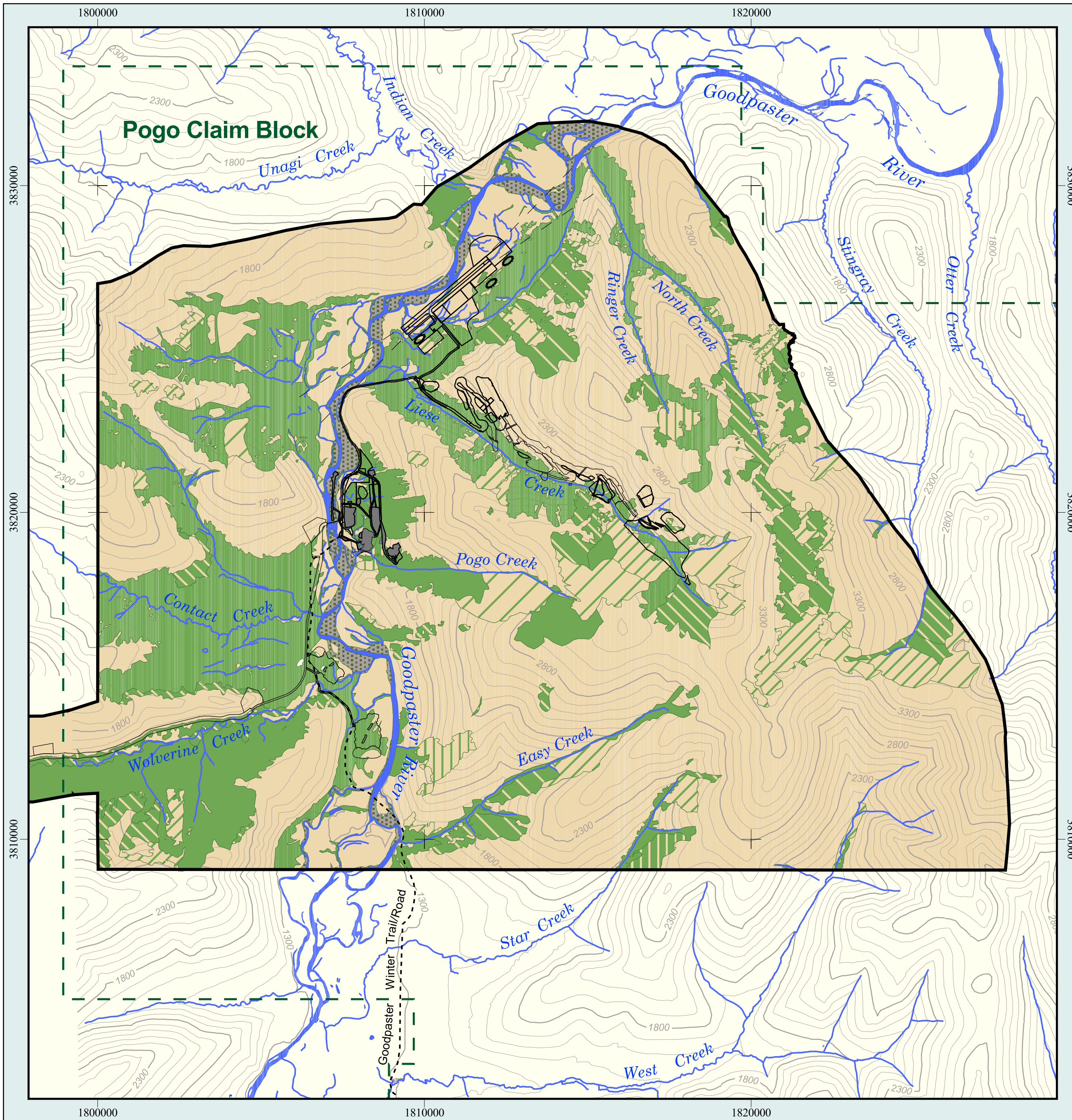
Streams in claim block area from USGS 1:63,360 dlg
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.11-1
Mapped Project Area Wetlands

map prepared by:
ABR inc
environmental research & services

26 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wetlands.apr



Legend

Wetlands

- Upland with up to 10 percent small wetland inclusions
- Upland with up to 25 percent small wetland inclusions
- Upland with up to 40 percent small wetland inclusions
- Wetlands
- Wetland with up to 10 percent small upland inclusions
- Wetland with up to 25 percent small upland inclusions
- Wetland with up to 40 percent small upland inclusions

Other Waterbodies

- Stream, River, Pond
- River Gravel Bar

- Study Area Boundary
- Areas of Proposed Mine Development (Soil Absorption System Option)
- Existing Disturbance
- Uplands

Source: Three Parameters Plus (2002f).

0.5 0 0.5 1 1.5 Kilometers

0.25 0 0.25 0.5 0.75 1 Miles

N W E S

Contours and original hydrography
by AeroMap U.S., Inc., 1997
Contour interval: 100 feet
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83; Grid: 10,000 feet

Pogo Mine EIS

Figure 3.11-2
Mine Area Wetlands

map prepared by:
ABR inc. environmental research & services

28 Jan 2003 | ABR File: Pogo_DEIS_Ch3_Wetlands.apr

Table 3-11.1 shows the proportion of the proposed mine vicinity and access corridors that are wetlands (Three Parameters Plus, 2002a). It also includes, under the heading “Other potential waters of the U.S.,” the acreage of lakes and ponds, broad rivers, and gravel bars. The area covered by small streams is included within the wetland acreages shown below because they are too narrow to be mapped as distinct polygons. Table 3.5-1 shows the major nonwetland “waters of the U.S.” regulated by the federal government. The mapped areas for the various access corridors overlap.

Vegetation types and some landscape positions most often associated with wetlands in the project area include open black spruce forests, medium-height shrub thickets on north-facing slopes or in low-lying or concave areas, open black and white spruce forests on lowlands and alluvial areas, alpine wet sedge meadows, willow thickets, tussock sedge meadows, and depressions supporting emergent aquatic herbs.

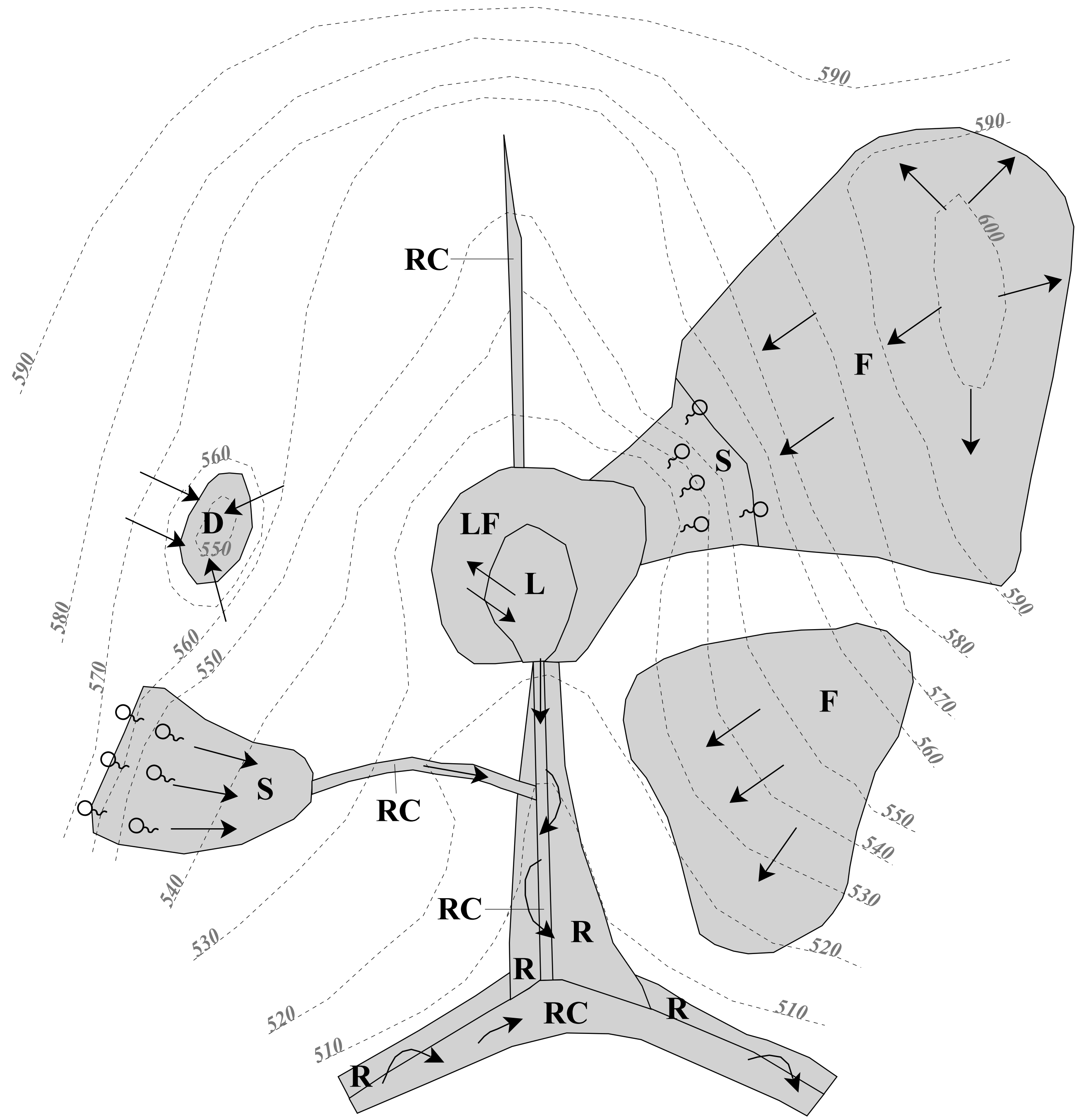
Typical soils found in wetlands include Pergelic Cryaquepts, Histic Pergelic Cryaquepts, Dysic Pergelic Sphagnofibrists, Pergelic Cryohemists, Pergelic Cryofluvents, Aeric Cryaquepts, Typic Cryofluvents, Typic Cryofibrists, Pergelic Cryofibrists, and Lithic Cryaquepts.

Wetland soils were either saturated with water when observed or their physical characteristics indicated saturation or flooding for at least part of the growing season in most years. Other indicators of wetland hydrology were ice-rich permafrost under a thick, moist, or saturated moss mat; seeps; tussocks, hummocks, or swales; and low-lying or depressional topography (Three Parameters Plus 2000a; 2001a).

3.11.2 Wetland Functions

Wetlands perform ecological functions, some of which are unique to wetlands. Some wetlands are valued by human society for the ecological functions they perform. For example, wetlands are recognized as protecting water quality, producing organic matter that supports aquatic and terrestrial food webs, moderating stream flows by maintaining base flows and storing water during storm runoff events, supporting wildlife and human uses of wildlife, and recharging water to aquifers.

For this discussion of wetland functions, terms of the hydrogeomorphic system of wetland classification and assessment are used. The hydrogeomorphic (HGM) approach to wetland assessment assumes that a wetland’s functions in the ecosystem are largely dependent on its geomorphic setting and the dynamics of its hydrologic system. That is, wetlands in the same HGM class—in similar landscape positions and with similar characteristics of water movement to, through, and from them—likely have similar ecological functions. HGM wetland types are described by Brinson (1993) and Magee and Hollands (1998). The types potentially affected by the Pogo project are discussed below. One other type—lake fringes—is very limited in the project area, would not be affected by the project, and thus is not discussed further, although its acreage in the study area is presented. Figure 3.11-3 depicts the landform and dominant water movement of the wetland types potentially affected by the project.



Legend

	Topographic Contour	**S**	Slope Wetland
	Direction of Surface Flow	**D**	Depressional Wetland
	Site of Groundwater Discharge	**F**	Flat Wetland
	Wetland	**LF**	Lacustrine Fringe Wetland
		L	Lacustrine Wetland
		R	Riverine Wetland
		RC	River Channel

Source: Adapted from D. Magee and G. Hollands. 1998.
A Rapid Procedure for Assessing Wetland Functional Capacity.

Pogo Mine EIS

Figure 3.11-3
Conceptual Hydrogeomorphic
Wetland Types

HDR Alaska — map prepared by: ABR Inc

18 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wetlands.apr

Table 3.11-1 Percentages of Wetlands Within Mapped Area

Mapped Area	Area Mapped (ac)	Estimated Wetland Area (ac)[1]
Mine Area[2]		
Upland with <10% wetland inclusions	355	35
Upland with 10-25% wetland inclusions	315	79
Upland with 25-40% wetland inclusions	62	25
Wetland with 25-40% upland inclusions	49	30
Wetland with 10-25% upland inclusions	285	213
Wetland with <10% upland inclusions	479	431
Wetland	2,801	2,801
Total Estimated Wetland Area		**3,614**
Other potential waters of the U.S.		
-ponds	5	0
-gravel bars	172	
-broad rivers	118	
Other upland and disturbed areas	7,567	0
Total Area Mapped	**12,208**	**3,614** (30% of mine study area)
Shaw Creek Hillside All-Season Road Corridor[3]		
Upland with <10% wetland inclusions	1,835	184
Upland with 10-25% wetland inclusions	801	200
Upland with 25-40% wetland inclusions	51	20
Wetland with 25-40% upland inclusions	85	51
Wetland with 10-25% upland inclusions	917	688
Wetland with <10% upland inclusions	594	535
Wetland	4,921	4,921
Total Estimated Wetland Area		**6,599**
Other potential waters of the U.S.		
-ponds	111	0
-gravel bars	348	
-broad rivers	312	
Other upland and disturbed areas	13,508	0
Total Area Mapped	**23,484**	**6,599** (28% of road corridor mapped area)
South Ridge All-Season Road Corridor[3]		
Upland with <10% wetland inclusions	2,867	287
Upland with 10-25% wetland inclusions	934	233
Upland with 25-40% wetland inclusions	26	10
Wetland with 25-40% upland inclusions	86	52
Wetland with 10-25% upland inclusions	503	377
Wetland with <10% upland inclusions	453	407
Wetland	1,320	1,320
Total Estimated Wetland Area		**2,686**
Other potential waters of the U.S.		
-ponds	6	0
-gravel bars	0	
-broad rivers	601	
Other upland and disturbed areas	11,054	0
Total Area Mapped	**17,850**	2,686 **(15% of road corridor mapped area)**
Shaw Creek Flats Winter Only Access Corridor[3]		
Upland with <10% wetland inclusions	1,756	176
Upland with 10-25% wetland inclusions	942	236
Upland with 25-40% wetland inclusions	283	113
Wetland with 25-40% upland inclusions	107	64

Table 3.11-1 Percentages of Wetlands Within Mapped Area

Mapped Area	Area Mapped (ac)	Estimated Wetland Area (ac)[1]
Wetland with 10-25% upland inclusions	968	726
Wetland with <10% upland inclusions	1,141	1,027
Wetland	6,798	6,798
Total Estimated Wetland Area		**9,139**
Other potential waters of the U.S.		
-ponds	128	0
-gravel bars	317	
-broad rivers	266	
Other upland and disturbed areas	11,433	0
Total Area Mapped	**24,140**	9,139 **(38% of road corridor mapped area)**

[1] Area mapped times maximum estimated percent wetland.
[2] The "Mine Area" includes the area shown in Figure 3.11-2 and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
[3] From beginning near Richardson Highway to where all three access corridors meet atop the Shaw Creek and Goodpaster River divide.

- **Flats** Flats are the most common wetlands in the project area. Their dominant water source is precipitation, and evapotranspiration from them approximately equals precipitation (Three Parameters Plus, 2001b). Water flow through them is generally minor and limited to unusual precipitation circumstances. At the Pogo project area, they are usually found on shallow to steep slopes, but also may occur on lowland flats and hilltop plateaus. Their vegetation is typically open or closed black spruce forest, shrub thickets dominated by dwarf birch, open white and black spruce forest, or it is dominated by sedge tussocks. The flats are generally underlain by permafrost.
- **Slope wetlands** The primary water source of slope wetlands is subsurface water moving to the wetland and discharging at its surface. Slope wetlands may also receive water from precipitation and surface flow. These wetlands typically occur on slopes, but at the Pogo project area they are generally located on relatively level toes of slopes and in lowlands adjacent to smaller streams and drainages (Three Parameters Plus, 2001b). The water movement in slope wetlands is unidirectionally downslope. In the Pogo project area, their vegetation is typically sedge tussocks, emergent herbs, shrub thickets dominated by alder or willow, or open black spruce forest.
- **Depressional wetlands** As the name indicates, these wetlands are located lower than the surrounding landscape. Water moves toward the lowest points of depressions by surface and shallow subsurface flow. Water sources are direct precipitation and overland and groundwater flow. Depressional wetlands may or may not have inlet or outlet channels; those in the project area tend to not have outlets (Moody, 2003). These wetlands are characterized by vertical fluctuations in the water table. This wetland type is scarce in the Pogo project area. Depressional wetlands in the project area are typically shallow open water areas with emergent vegetation and also occur as open black spruce forests in the relic dunes along the northwest side of Shaw Creek.
- **Riverine wetlands** Riverine wetlands occur in valleys along streams and are influenced by fluctuations in stream flows. They may receive water from precipitation, surface or shallow subsurface flows, or overbank flooding of the stream. Surface flow is generally unidirectional toward downstream and, at times of flooding, the water has high energy. Water can also flow over the stream banks, into and out of the wetland. At the Pogo project area, riverine wetlands occupy narrow valley bottoms of the smaller streams and abandoned channels and oxbows of the Goodpaster River.

The vegetation of riverine wetlands is typically open black or white spruce forests or shrub thickets dominated by alder or willow. In this document, gravel bars (vegetated and unvegetated), although technically "waters of the U.S." but not always wetlands, are included within the "riverine" wetlands acreage and discussion. They often support small inclusions of wetlands, and they perform many of the same important functions as do the true wetlands along streams (Three Parameters Plus, 2001b).

Wetland functions for the HGM wetland types found in the project area are identified, discussed, and defined by Magee and Hollands (1998), ADEC/COE (1999), and Brinson et al. (1995). These wetland functions are listed in Table 3.11-2, with an indication whether the wetlands of each HGM class in the Pogo project area are likely to perform that function to any substantial degree. This table is excerpted from a table developed by a team of agency staff and other wetland scientists based on best professional judgment and familiarity with the project area.

The area of each HGM wetland type in the project area is shown in Table 3.11-3 and the percent of the wetland area represented by each of these types is shown in Table 3.11-4 (Three Parameters Plus, 2002a). Although they may not be wetlands in the strict sense, the areas of ponds and gravel bars have been included in both of these tables because they are aquatic sites that perform functions similar to the wetlands of the same HGM types. Broad rivers are not included in the acreages below, and the areas of narrow streams are included with the HGM types or uplands that surround them. Acreages for all the mapped areas cannot be totaled because the access corridor study areas overlap.

Table 3.11-2 Expected Functions of Pogo Project Area Wetlands by Hydrogeomorphic Class

Function	Function Definition	Flats	Slope Wetlands	Depressional Wetlands	Riverine Wetlands
Hydrologic Functions					
Modification of Groundwater Discharge	The capacity of a wetland to influence the amount of water moving from ground water to surface water. [1]	No	Yes	No	No
Modification of Groundwater Recharge	The capacity of a wetland to influence the amount of water moving from surface water to ground water. [1]	No	No	No	No
Modification of Stream Flow	The modification of hydrologic inputs (precipitation, surface water, or groundwater) by detention or retention of water on the wetland surface and in its soil.[1]	Yes	Yes	Yes	Yes
Maintenance of Soil Thermal Regime	The capacity of a wetland to maintain or return to characteristic soil thermal conditions. [3]	Yes	Yes	Yes	No
Biogeochemical Functions					
Export of Detritus	Export of organic detritus from the wetland to adjacent and downstream aquatic ecosystems. [1]	No	Yes	No	Yes

Table 3.11-2 Expected Functions of Pogo Project Area Wetlands by Hydrogeomorphic Class

Function	Function Definition	Flats	Slope Wetlands	Depressional Wetlands	Riverine Wetlands
Modification of Water Quality	Removal of suspended and dissolved solids from surface water and dissolved solids from ground water and retention or conversion into other forms, plant or animal biomass, or gases. [1]	No	Yes	Yes	Yes
Habitat Functions					
Contribution to Abundance and Diversity of Wetland Fauna	The capacity of a wetland to support large and/or diverse populations of animal species that spend part or all of their life cycle in wetlands.[1]	Yes	Yes	Yes	Yes[4]
Contribution to Abundance and Diversity of Wetland Vegetation	The capacity of a wetland to produce an abundance and diversity of hydrophytic plant species, including dead plant biomass of all sizes. [1,2]	Yes	Yes	Yes	Yes

1 Adapted from Magee and Hollands (1998)
2 Adapted from Brinson et al. (1995)
3 ADEC/COE (1999)
4 Riverine wetlands could directly support fish.

Table 3.11-3 Area of Wetland Hydrogeomorphic Type in Mapped Areas (acres) [1]

Mapped Wetland Type	Mine Area[2]	Shaw Creek Hillside Corridor[3]	South Ridge Corridor[3]	Shaw Creek Winter Route Corridor[3]
Flats	1,150	614	476	738
Flat/Upland Mosaics	730	850	990	1,454
Flat/Slope Mosaics	1,109	3,153	345	4,428
Slope Wetlands	420	1,169	449	1,659
Slope/Upland Mosaics	4	395	357	458
Depressional Wetlands	1	47	0	27
Riverine Wetlands	298	529	26	519
Riverine/Upland Mosaics	80	300	20	298
Lake Fringes	0	0	30	3
Total	3,792	7,058	2,693	9,585

1 Acreages exclude the portion of each mosaic estimated to be upland. Flat/slope mosaics were assumed to be 50 percent flats and 50 percent slopes.
2 The “Mine Area” includes the area shown on Figure 3.11-2, and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
3 From beginning near Richardson Highway to where access route option corridors meet atop the Shaw Creek and Goodpaster River divide.

Table 3.11-4 Percentage of Each Wetland Hydrogeomorphic Type in Mapped Areas

Mapped Wetland Type	Mine Area[1]	Shaw Creek Hillside Corridor[2]	South Ridge Corridor[2]	Shaw Creek Winter Route Corridor[2]
Flats	64	43	61	46
Slope Wetlands	26	44	36	45
Depressional Wetlands	0	1	0	0
Riverine Wetlands	10	12	2	9
Lake Fringes	0	0	1	0
Total	100	100	100	100

[1] The "Mine Area" includes the area shown on Figure 3.11-2, and approximately 2 miles of the access corridor extending westward from the mine area to where the access route option corridors diverge atop the Shaw Creek and Goodpaster River divide.
[2] From beginning near Richardson Highway to where access route option corridors meet atop the Shaw Creek and Goodpaster River divide.

3.12 Surface Disturbance

There is relatively little existing surface disturbance in the vicinity of the mine site and along the surface access route options. To date, Pogo exploration activities by the Applicant and a previous claims owner have disturbed approximately 30 acres in the vicinity of the mine.

- Three acres related to surface exploration at the Liese Ridge exploration (upper) camp and for surface drill sites (outside of the proposed mine site footprint)
- Seven acres for the advanced exploration (lower) camp below the 1525 Portal
- Four acres for gravel pits
- Four acres for the airstrip and access roads
- Six acres for the 1525 Portal pad and access road
- Six acres for rock storage pads

Table 3.12-1 shows the approximate acreage of existing disturbance along each of the surface access and power line routes.

Table 3.12-1 Approximate Area of Existing Surface Disturbance (Acres) Within the Surface Access and Power Line ROWs for Each Route Option[1]

Route	Surface Access	Power Line	Total
Shaw Creek Hillside	25.5	1.1	26.6
South Ridge	1.9	3.0	4.9
Winter only access perennial winter trail	56.1	N/A	56.1

[1] Includes camps, airstrips, and gravel pits

3.13 Fish and Aquatic Habitat

The proposed Pogo Mine project would be developed in the drainages of the Goodpaster River and Shaw Creek, two tributaries of the Tanana River with substantial fish resources. Their aquatic habitats are distinctly different due to their water sources. Water source is a major variable determining stream and river characteristics and the aquatic communities present (Milner *et al.*, 1997). Over the length of the Goodpaster River and Shaw Creek waterways, characteristics of their water sources produce varying habitats, which affect the presence, abundance, and composition of individual fish species. Habitat use, however, is similar between species in both drainages. For the majority of fish, the basic life history strategy involves seasonal movements to those habitat types that best serve the needs of spawning, rearing, feeding, and overwintering. These preferred habitats differ depending on the life stage of the fish. The extent of movement can be small and confined within a section of the river or large, covering 100+ miles and involving one, two, or more rivers and, for salmon, thousands of miles. The net result is that species distribution, abundance, and composition within the Goodpaster and Shaw Creek drainages change over time and place. And just as importantly, the exploitation of some species can extend beyond the two drainages.

Since 1956, numerous studies of the aquatic resources in the Goodpaster River and Shaw Creek have been conducted by USFWS and ADFG. These studies have focused predominantly on game fish, specifically Arctic grayling (*Thymallus arcticus*), in the lower reaches of both rivers (Ridder, 1991). Intermittent aerial surveys for spawning salmon in the Goodpaster have been flown by the USFWS and ADFG since 1954. In 1996, the Applicant initiated a series of aquatic resource studies in the upper Goodpaster River to support the baseline information needs of its proposed Pogo Mine. These baseline studies were the first of their kind in the drainage and included quality of water and fine-grained streambed sediment, ambient toxicity testing, aquatic macroinvertebrates, and fish. For fish, major emphasis was on chinook salmon (*Oncorhynchus tshawytscha*) as the major “indicator” species with delineation of spawning and rearing habitat, tissue analysis, and development of abundance indices for adults and juveniles. The Applicant also funded an ADFG monitoring program for adult Arctic grayling spawning in the river's lower 33 miles. Following is a synopsis of the fish and aquatic habitat of the Goodpaster River and Shaw Creek based on these studies.

3.13.1 Goodpaster River

The Goodpaster River is a typical Alaskan clear water drainage with year-round flow predominantly derived from precipitation and shallow ground water. From its origin in the Tanana Uplands, the river flows approximately 140 miles to the Tanana River, draining an area of approximately $1{,}600^{+}$ sq mi (Figure 1.3-1). Its two largest tributaries, both downstream of the proposed mine site, are the South Fork, which enters the river 33 miles above its mouth (river mile 33), and Central Creek, which enters at river mile 61. Below the confluence of the South Fork, the river can be characterized as generally shallow (< 40 in.) but wide (160 ft), slow moving, and meandering. It has a substrate predominantly of sand with isolated riffle areas composed of broad expanses of pea-sized gravel (Van Wyhe, 1964). Upstream of the South Fork confluence, the river is composed of a main stem, side channels, and sloughs and has a moderate and uniform gradient characterized by a classical sequence of riffles, runs, and pools with a predominant substrate of gravel (Morsell, 2000). The Pogo claim block encompasses 11 river miles, with the mine site located adjacent to the river at approximately its mid-point at river mile 70 (Figure 1.3-2).

The aquatic environment in the vicinity of the Pogo claim block is generally pristine, with overall water quality and physical characteristics typical of unpolluted subarctic Alaskan streams (Boggs, 2001a). Aquatic and riparian habitat evaluations of eight sites within the project area from 1998 through 2000 returned “optimal” scores for all parameters (Boggs, 2001b). No major differences in water quality parameters were found between main stem sampling sites above, adjacent to, or below the mine site and Central Creek. There were differences between Central Creek and the smaller tributary sites, especially Liese and Pogo creeks (Boggs, 2001a). Major and trace metal concentrations tended to be higher in the smaller tributaries. No water quality parameters at any site subject to EPA fresh water aquatic life standards for priority pollutants exceeded the CMC (EPA, 1988). However, 6 of 97 samples from the main stem and 2 of 29 samples from Liese Creek did exceed the CCC either for lead, mercury, or both (Section 3.7.1). For nonpriority pollutants, aluminum and iron concentrations exceeded EPA fresh water aquatic life standards in some samples from the main stem and tributaries.

Aquatic organisms can be extremely sensitive to contamination levels. Background toxicity of water samples from the main stem and Liese, Pogo, and West creeks was investigated in 1999 and 2000 on two test species not indigenous to the area. Ambient toxicity tests showed effects on reproduction, survival, and growth in two of seven samples. Effects were dependent both on the test species and source of water (Boggs, 2001c). The 2000 sample from upper West Creek affected the reproduction but not the survival of the freshwater crustacean *Ceriodaphnia dubia*. The 1999 sample from Liese Creek had a deleterious effect on survival and growth of fathead minnows (*Pimephales promelas*). No effects were found from the other samples. Both Liese and West creeks drain the mineralized zone. Liese is ephemerally connected to the main stem, and upper West disappears into a wetland complex before reappearing and entering the main stem.

Fish tissue (whole body) analysis for eight trace metals was conducted on juvenile chinook salmon collected in the main stem above and below the claim block for 3 years, 1998–2000 (Morsell, 2000). Concentrations of antimony, arsenic, and silver were at or below detection limits for all samples. Selenium concentrations were mostly below detection limits in 1999 and just above detection limits in 1998 and 2000. Comparisons of upstream versus downstream samples showed no statistical differences in metal concentrations, with the exception of mercury in 1999 which, while low, was higher in the downstream sample. Copper, lead, and nickel were exceptionally higher in 2000, especially in the upstream sample, than in 1998 and 1999 and suggested contamination of the samples. With the exception of copper in the upstream 2000 sample, metal concentrations were similar to or lower than those found in salmonid tissues (whole body) collected in other areas of the state (Weber-Scannell, 2001).

Three years of baseline studies of the aquatic invertebrate community within the project area found species composition and taxa numbers comparable to those in other pristine streams in the region (Boggs, 2001b). Seven invertebrate orders were found encompassing 24 families and 38 genera. These studies developed eight characteristics, or metrics, of the invertebrate community for use in comparing the project area sample sites and as indicators of habitat change for future bioassessments. Metric values showed no statistical differences between main stem sites upstream and downstream of the claim block and near the proposed mine site. Sites in Liese, Pogo, West, and Indian creeks showed a statistical difference in several metrics compared to the main stem sites. These sites had greater numbers of Chironomidae and Simulidae, which can be indicative of poorer habitat. While population densities of invertebrates in the three main stem sites showed a statistically significant decrease from the most upstream site, it is likely an artifact of sampling from decreased access to habitat at downstream sites due to higher discharge.

Eleven fish species have been found in the Goodpaster River (Roach, 1995). Seven of these species have been found within or directly downstream of the Pogo claim block. The most numerous were chinook salmon, Arctic grayling, slimy sculpin (*Cottus cognatus),* and chum salmon (*Oncorhynchus keta)*, while round whitefish (*Prosopium cylindraceum)*, burbot (*Lota lota)*, and Arctic lamprey (*Lampetra japonic)* appeared least numerous (Morsell, 2000; Parker, 2000a). Humpback whitefish (*Coregonus pidschian)*, least cisco (*Coregonus sardinella)*, longnose sucker (*Catostomus catostomus)*, and northern pike (*Esox lucius)* have been found in the lower 33 miles.

The sport fishery in the Goodpaster River is primarily on Arctic grayling in the lower 33 miles during the open water season, May through September. The fishery also harvests low numbers of northern pike, burbot, and whitefish (Tack, 1974; Parker, 2000a, 2000b). The sport fishery on chinook and chum salmon is closed by regulation. There are presently no subsistence or commercial fisheries in the river. An unknown number of Goodpaster River salmon, however, are taken in such fisheries in the Yukon and Tanana rivers (Barton, 2000). From 1983 through 1998, effort in the sport fishery has ranged from 800 to 3,100 anglers per day and averaged 1,700 (Parker, 2000b). The grayling fishery, which predominantly targets juvenile fish less than 12 in. (Tack, 1974), had an average harvest of 1,200 grayling per year since 1983 and an average total catch (fish harvested plus fish released) of 1,600 since 1990. The trend since 1995 has been a declining harvest but an increasing catch (yearly average of 600 fish harvested from a total of 3,400 grayling caught) (Parker, 2000b). Yearly harvests and total catch of northern pike, burbot, and whitefish (spp.) have been less than 80 fish each (Parker, 2000b, ADFG files).

Following is a synopsis of the biology of the seven fish species found in the Goodpaster River in the vicinity of the Pogo claim block.

Chinook Salmon

The Goodpaster is the uppermost spawning tributary in the Tanana Drainage for chinook salmon. Intermittent aerial surveys by ADFG of spawning escapement between 1954 and 1998 have counted from 18 to 1,400 fish. Escapement counts have averaged 630 fish between 1990 and 1995 (ADFG file data). Aerial surveys, however, are a snapshot of what is in the river at a given time and hence are indices of escapement and do not represent the total escapement. Aerial surveys using fixed wing aircraft have undercounted total chinook escapement by 71 percent in the Chena River and 57 percent in the Salcha River (Stuby, 1999). Surveys using a helicopter or a boat provide a more accurate escapement index and better estimate total escapement in moderate to small-sized waters like the Goodpaster when conducted at peak spawning times (Evenson, 2000). Such helicopter surveys were conducted in the Goodpaster River in 1973 and 1998 through 2000, and a boat survey was conducted in 1974. These surveys show that recent escapements are increasing and are substantially higher than in the 1970s (Table 3.13-1).

For some perspective into the size of the Goodpaster escapement, the average escapement index in 1998 and 1999 was 10 to 27 percent of the total estimated escapement in the Chena and Salcha rivers (Table 3.13-1), two of the largest chinook escapements in the Yukon River drainage (Schultz *et al*., 1994). Since the Goodpaster data are indices and, at best, minimum estimates of total escapement, the river may contribute more to the drainage-wide chinook run than previously thought (Fogels, 2003).

Chinook first enter the Goodpaster in the first weeks of July and choose spawning sites in gravel and gravel/cobble substrates in depths of 1 to 3 ft (Tack, 1975; Morsell, 2000). The run is composed of three to four age groups with 5- and 6-year-old fish representing 80 to 90 percent of the run (ADFG files). Spawning areas are located in 90 miles of the river from approximately river mile 30 to river mile 120. Spawning densities generally decreased with distance upstream due to flow and depth, and thus few fish spawn above Slate Creek at river mile 102. The majority of fish, 95 percent in the 2000 whole river survey, spawn in the 69 miles between the South Fork at river mile 33 and Slate Creek (Morsell, 2000). Sixty-five chinook also were found in the South Fork in 2000 (Morsell, 2000). The only previous survey in the South Fork was by helicopter in 1973, and no salmon were found (ADFG files; Barton, 2000). No chinook have been found spawning in Indian or Central creeks (Morsell, 2000), the largest tributaries surveyed after the South and Eisenmenger forks. Spawning in other tributaries in the mine area is nonexistent due to their small size. In 1999 and 2000, 76 and 67 percent, respectively, of all chinook spawned downstream of the Pogo Mine airstrip at approximately river mile 70 (Morsell, 2000). Twenty-one percent of the 3 river miles encompassing and extending upstream and downstream from the existing airstrip was classified as spawning habitat (Morsell, 2000).

Table 3.13-1 Comparison of Chinook Salmon Escapement Indices in the Goodpaster River to Total Estimated Escapement in the Chena and Salcha Rivers

Year	Goodpaster	Chena	Salcha
1973	18	N/A	N/A
1974	248	N/A	N/A
1998	477	4,745	5,027
1999	1,743	6,485	9,198
2000	2,240	4,462	N/A

Goodpaster data from: ADFG files, 1974; Tack, 1975; and Morsell, 2000.
Chena and Salcha data from Stuby (1999, 2001).

Table 3.13-2 shows that distribution of Goodpaster River chinook salmon spawners from 1998 through 2000 was similar to that found in 1974 (Morsell, 2000; Tack, 1975).

Table 3.13-2 Distribution of Spawning Goodpaster River Chinook Salmon in 1974 and 1998-2000

		1974		1998		1999		2000	
River Reach	Miles	n	p	n	p	n	p	n	p
Forks to Central	28	153	0.63	289	0.61	1,051	0.60	979	0.47
Central to Indian	13	41	0.17	107	0.22	348	0.20	501	0.24
Indian to Glacier	12	29	0.12	16	0.03	176	0.10	239	0.12
Glacier to Slate	16	21	0.09	65	0.14	168	0.10	353	0.17
Total	69	244	1.00	477	1.00	1,743	1.00	2,072	1.00

n = number
p = percent

Source: Morsell (2000)

Chinook spawn during an approximately 3-week period beginning the last two weeks of July, with the peak occurring approximately August 1 (Morsell, 2000). With an average water temperature between August and May of 35° F (Boggs, 2000a), the thermal sum model of Healey (1991) predicts 247 days to hatching. Thus, hatching in the proposed mine area likely would occur from the last week in March through mid-April (Table 3.13-3).

After hatching, the alevins spend 3 or more weeks in the gravel absorbing their yolk sac before emerging as fry sometime in May (Morrow, 1980; Table 3.13-3). This timetable is supported by the capture in mid-May within the mine area of small fry (1.2 to 1.6 in.) that appeared to have just emerged (Morsell, 2000). Chinook typically rear for 1 year in the river before outmigrating as smolts in May. Late winter sampling in the mine area captured chinook in the main stem and lower Central Creek, indicating overwintering in the proposed mine area (Morsell, 2000). A few large juveniles, likely in their second year, have been captured in October, suggesting that some fish may spend 2 years in the river. These fish, however, have never been found as adults in the river. In the Chena and Salcha rivers, chinook with 2 years of freshwater residency, when present, comprise less than 1 percent of returning adults (Evenson, 2000).

Juvenile chinook were found in a variety of habitats in the main stem, side channels, and sloughs throughout the Pogo mine area from March through October (Morsell, 2000). The use of the area's tributary streams is much lower than for the main stem areas but appears to be dependent on main stem flows and habitat availability. Of the five tributaries that may be directly affected by the mine proposal – Liese, West, Pogo, Wolverine, and Central creeks – rearing chinook were found only in the lower reaches of the latter two (Morsell, 2000). Liese Creek disappears into a wetland and may be ephemerally connected to the Goodpaster River. No fish have been found in upper Liese Creek, and it is not considered fish habitat (Morsell, 2000). West Creek is similar to Liese Creek in that it disappears into a wetland complex. Unlike Liese Creek, it emerges below the complex and runs for 0.6 mile to the Goodpaster. Fish were found in this lower section, but not in the wetland complex or farther upstream. In Pogo Creek, a beaver dam limited fish to a very short stretch near the mouth. Upstream of the dam, gradient and flow are not hospitable to fish (Morsell, 2000). Wolverine Creek, the drainage in which the all-season or winter access road would be sited, has quality rearing and overwintering habitat in the 3/4 mile upstream of its mouth, and numerous rearing chinook were present. Chinook were found only in the lower reaches of Central Creek, despite excellent upstream habitat. Although index sampling shows that chinook prefer main stem habitats, they seek refuge in tributaries during periods of high flows. In high and fast water during the summer of 2000, chinook were found to be much more abundant in West and Central creeks than under low-flow conditions in 1998 and 1999 (Morsell, 2000).

Chum Salmon

The river has a summer run of chum salmon that lags behind the chinook run (Table 3.13-3). Peak chum spawning in 2000 was estimated to be 9 days behind that of chinook (Parker, 2000a). In the Salcha River, lag time between chum and chinook has been up to 18 days (Stuby, 1999). Because all escapement surveys in the Goodpaster have targeted the earlier chinook run, chums have been observed in only 10 of the 22 surveys conducted since 1954, with counts ranging from 31 to 224 fish (ADFG files). A contributing factor to the absence of chum in these surveys may be the habit of pre-spawning chum to hold in deep water adjacent to steep vegetated banks, making them difficult to see from the air, especially in the river's tannic stained waters (Barton, 2000). On an August 9, 2000, float trip that sampled chinook carcasses, 2,500 chum were counted within a 5-mile reach upstream of Sand Creek, whereas an aerial survey on July 31 counted only 150 chum in the same area (Parker, 2000a; Morsell, 2000).

The spawning area for chum appears to be much more limited than that for chinook. All observations have been in the 28 miles between the South Fork and Central Creek. In the five surveys delineated by river sections, chums have not been observed above Seven Mile Creek, approximately 15 miles downstream of the existing Pogo Mine airstrip. Morsell (2000), however, reported 18 “probable” chum in the middle portion of Central Creek in 1999, but was unable to confirm the sightings from the ground.

Chum spawn in the river during an approximately 6-week period beginning the first week of August. The run is composed of three to four age groups with 4- and 5-year-old fish representing 80 to 90 percent of the run (ADFG files). The peak of spawning, assuming a residency of 11 to 15 days (Sato, 1991), occurs approximately August 12. Assuming 140 days for incubation (Sato, 1991), hatching likely would occur from the last week in December through January (Table 3.13-3). After hatching, the alevins spend 100^{+} days in the gravel absorbing their yolk sac before emerging as fry sometime in April (Sato, 1991; Table 3.13-3). The fry immediately outmigrate starting at ice-out in late April through mid May. Due to distribution, behavior, and limited pre-ice-out sampling, no captures or observations of fry have been made within the Pogo claim block.

Table 3.13-3 Periodicity Chart for Five Fish Species in the Upper Goodpaster River Drainage

Chinook Salmon	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration[1]																									x	x	x	x																				
Spawning																										x	x	x	x	x																		
Incubation	x	x	x	x	x	x	x	x	x	x	x	x	x	x												x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emergence																	x	x	x	x																												
Rearing/Feeding	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DS migration[2]																	x	x	x	x																												
Critical OW[3]			x	x	x	x	x	x	x	x	x	x	x																																			

Chum Salmon	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration																													x	x	x	x	x															
Spawning																														x	x	x	x	x														
Incubation																														x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emergence													x	x	x	x																																
Rearing/Feeding	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																														
DS migration																x	x	x																														
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

Arctic Grayling	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration:																																																
Adults																x	x	x	x	x	x																											
Juveniles																			x	x	x	x	x																									
Spawning																		x	x	x	x																											
Incubation																		x	x	x	x	x	x																									
Emergence																				x	x	x	x	x	x																							
Rearing/Feeding	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	s	s	s	s	s	s	s	s	s	s
DS migration																																		x	x	x	x	x	x	x	x	x	x	x				
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

Round Whitefish	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration:																																																
Adults																x	x	x	x	x													x	x	x	x												

Table 3.13-3 Periodicity Chart for Five Fish Species in the Upper Goodpaster River Drainage

Juveniles																x	x	x	x	x																												
Spawning																																			x	x	x	x										
Incubation	x	x	x	x	x	x	x	x	x	x	x	x	x	x																					x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emergence											x	x	x	x	x	x	x																															
Rearing/Feeding	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	s	s	s	s	s	s	s	s	s	s
DS migration																																					x	x	x	x	x	x						
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

Slimy Sculpin	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
US migration																																																
Spawning																		x	x	x	x																											
Incubation																		x	x	x	x																											
Emergence																																																
Rearing/Feeding	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DS migration																																																
Critical OW			x	x	x	x	x	x	x	x	x	x	x																																			

[1] US migration = upstream migration.
[2] DS migration = downstream migration.
[3] Critical OW = critical overwintering. Defined by minimum flows as found in the Goodpaster River by Beckstead (2000).
s = suspected.

Source: Modified from ADFG (2000)

Arctic Grayling

Arctic grayling are found in the majority of the Goodpaster drainage and are perhaps its most important fish resource (Tack, 1974, 1980; Parker, 2000a). The population consists of at least 14 age classes. Grayling begin maturing at Age 4 and attain full maturity by Age 8 (Clark, 1992a). The Goodpaster population, as do others in Alaska, has a life history involving complex migrations between overwintering, spawning, and summer feeding areas that differ between juveniles and adults and can involve different waters (Tack, 1980; Ridder, 1991). Tagging studies have shown the Goodpaster as a spawning area for, and therefore a source of, fish that contribute to five other sport fisheries in the Tanana River drainage (Ridder, 1991). The largest contribution is to the nearby Delta Clearwater River, where 60 percent of its population of adult grayling spawn in the lower Goodpaster (Ridder, 1998a). Movements also significantly affect the abundance and composition of juvenile and adult fish in place and time (Ridder, 1998c). For example, adult fish were 10 times more numerous in the lower 33 miles of the Goodpaster during spawning in May than in July (Ridder, 1998b).

Grayling spawn in the spring shortly after breakup, usually in May, when water temperatures first reach 41° F. River temperatures warm first in the lower reaches; therefore, spawning begins in the lower river and reaches upstream areas weeks later (Tack, 1980; Ridder, 1998c; Table 3.13-3). Preferred spawning areas are in riffle habitats with pea-sized gravel, although a variety of habitats have been used (Tack, 1980). Spawning in the Goodpaster, documented by captures of gravid fish and/or fry, occurs from the mouth through the proposed mine area to at least river mile 115 and at least 26 miles up the South Fork (Tack, 1974; Ridder, 1998b; Morsell, 2000). No spawning has yet been documented in other Goodpaster tributaries. If it does occur, it is likely insignificant to main stem and South Fork spawning. Abundance of adult-sized fish (larger than 12 in.) in 60 river miles from Central Creek downstream to the mouth was 16,600 fish during spawning in 1995 (Ridder, 1998b). Average density was higher in the lower 24 miles (300 fish per mile) than the 23 miles below Central Creek (190 fish per mile). Densities are likely lower above Central Creek as stream size and preferred habitat diminishes. From 1995 through 1999, estimated abundance of adult-sized fish during spawning in the lower 33 miles has ranged from 9,000 to 17,000 fish (Ridder, 1998b; Parker, 2001).

After spawning, eggs develop quickly. At water temperatures of 46° F, hatching occurred in 14 days, after which the alevins remain in the gravel absorbing their yolk sac for 3 to 4 days prior to emergence (Armstrong, 1982; Table 3.13-3). At emergence, fry are poor swimmers and seek out quiet water in shallow riffles at the lower end of gravel bars, sloughs, and backwaters. At this stage of development, flood events displace fry downstream and can cause high mortality either directly from turbulent flows or indirectly by displacing fish into unfavorable habitats. Clark (1992b) found stream flows directly affected recruitment of grayling in the Chena River. Morsell (2000) found fry abundant in preferred habitat throughout the Pogo claim block in 1999, but not within tributaries. However, fry were nearly nonexistent in the same areas in 2000, when several periods of high water occurred in June and July. Flood events may also affect young-of-the-year fish later in the season. Tack (1974) suggested that the Chena River flood of August 1967 caused high mortality among young-of-the-year fish because samples in subsequent years were missing that age group.

After spawning, the majority of grayling, adults and juveniles, disperse upstream to summer feeding areas. In a Chena River study, the extent of the upstream movement of adults was generally dependent on where a fish spawned and where it had spent the previous summer (Ridder, 1998c). Fish spawning in the lower drainage moved the greatest distances to at least mid-drainage locations; fish spawning in mid-drainage moved to the upper drainage; and fish spawning in the upper drainage moved into headwaters. In the Goodpaster, 10 to 15 percent of grayling that spawned in the lower 20 miles migrated to other rivers, principally the Delta Clearwater River, 9 percent remained in the area, and the remainder moved upstream (Ridder, 1998b). For fish 6 in. and longer, Tack (1974) described an upstream post-spawning movement in early June followed by a mid-summer period of little movement but with the greatest dispersal. In mid-summer, he found juveniles and subadults in the lower 33 miles; a mix of these groups, including adults in the middle drainage; and mostly adults above Central Creek. Grayling index sampling in the Pogo mine area in 1999 and 2000 confirmed this pattern, with small May catches of ripe or spawned out adults solely in the main stem and high mid-summer catches of juveniles and adults in the main stem and Central and Wolverine creeks (Morsell, 2000). The mid-summer catch included adults tagged during spawning in the lower river.

Mid-summer density estimates in the river's lower 33 miles have ranged from 215 to 783 Arctic grayling (6 in. and longer) per mile, with adult sized fish (11 in. and longer) at 32 to 115 fish per mile (Roach, 1995). Tack (1974) estimated the mid-summer population (6 in. and longer) from the mouth to river mile 115 at 47,000 fish. Fifty-five percent of the fish were in the lower 33 miles; 28 percent were in the 28 miles between the South Fork and Central Creek; and 17 percent were in the 54 miles upstream of Central Creek.

Grayling in rivers like the Goodpaster move downstream to overwintering areas in a leisurely fashion beginning in late September and extending to December (Tack, 1980; Lubinski, 1995; Ridder, 1998c; Table 3.13-3). Morsell (2000) found lower numbers of fish, mostly adult males, in the proposed mine area during October in 1999 and 2000. Fish had moved out of tributaries and were concentrated in the airstrip area. The extent of this movement to overwintering areas is generally dependent on where the fish spent the summer. Prior to 1990, grayling were thought to move in mass to the lower portions of rivers for overwintering. Several recent studies, however, have shown that some grayling summer feeding in headwater areas move downstream relatively short distances to overwintering areas (Hughes, 2000; Lubinski, 1995; Ridder, 1998c). In the Chena River, grayling in headwater areas moved the least, and contrary to fish from other areas, some also moved downstream to spawning areas (Ridder, 1998c). Grayling in the Chena generally were found to overwinter within 16 miles of their spawning sites. Overwintering grayling have been documented in the lower 33 miles of the Goodpaster (Ridder, 1998a) and upstream of the mine site (Morsell, 2001).

Slimy Sculpin

Slimy sculpin are small, bottom-feeding fish that occur throughout the Goodpaster drainage. The fish, generally unknown to the public, may be the most abundant fish in clear Alaskan streams and hence ecologically important (Sonnichsen, 1981). A solitary, sedentary, bottom-feeding fish, it is likely the only fish resident within the proposed mine area and also the most widely distributed. As with juvenile chinook, however, it was not found in Liese, upper Pogo, or West creeks (Morsell, 2000). Fish sampled in the mine area ranged from 1.8 to 3.8 in. and averaged 2.6 in. (Morsell, 2000). The fish grows slowly and has a maximum age of 7 years in interior Alaska (Morrow, 1980; Sonnichsen, 1981). The fish reach maturity at Ages 3 and 4, and spawn in the spring when water temperatures are between 39° F and 50° (Morrow, 1980; Table 3.13-3). Nests are constructed under rocks, trees, and/or roots in shallow water less than 12 in. deep. Incubation takes approximately 30 days with fry, a quarter inch long, remaining in the nest another week absorbing their yolk sac (Morrow, 1980; Table 3.13-3).

Three other fishes, round whitefish, burbot, and Arctic lamprey, were found in very small numbers within the proposed mine area during 1998 - 2000 surveys (Morsell, 2000). The numbers may reflect incidental use of the area or limited sampling methods and timing.

Round Whitefish

Two young of the year-round whitefish were captured in July 1999, one in the airstrip slough and one in the main stem below Central Creek. Considering that the fish were less than 2 in. long, they were unlikely to have moved upstream but may have been displaced downstream. Thus, spawning likely occurred either instream or upstream of the proposed mine area the previous fall. Movements and biology of the species is not well known in Alaska, but fall movements to spawning areas and spring movements to feeding areas have been noted. Concentrations of pre-spawning round whitefish were found in the 10 miles below Central Creek in mid-September 1973 and included two fish previously tagged in the Delta Clearwater River (Pearse, 1974). The fish are known to spawn in late September to mid-October in shallow gravels, with fry emerging the following spring (Morrow, 1980; Table 3.13-3). Fish are thought to move downstream for overwintering; however, Lubinski (1995) found small numbers of whitefish overwintering with grayling in upper Birch Creek, a large tributary to the Yukon River. One adult fish was observed under the ice in March above the mine site (Morsell, 2001). Large adults are commonly caught in the lower Goodpaster in May (Parker, 2000a). Fish overwintering in the Tanana River move into the Delta Clearwater River for summer feeding and then leave the river in late August with some spawning in the Goodpaster (Pearse, 1974). Tack (1974) captured juvenile and adult round whitefish in the Goodpaster at river mile 33 moving upstream in early May right after ice-out. Thus, some whitefish overwinter, summer feed, and spawn in the main stem within the mine area.

Burbot

Fourteen Burbot were caught in 11 of 417 minnow traps that were fished for over 9,000 hours from 1999 through 2000 (Morsell, 2000). All were captured in main stem sets and were immature fish 4 to 8 in. long representing 1- and 2-year-old fish. Larger-sized burbot are fairly common year-round in the lower Goodpaster. Burbot use of the upper river likely is limited to a juvenile feeding area because spawning would occur only in the lower reaches (Evenson, 2000). McPhail and Lindsey (1970) mention upstream post-spawning runs of young fish, at Ages 1 and 2, that feed on insects and small sculpin. Because minnow traps are an effective capture method (Evenson, 2000; Ott, 2001), the low capture rate indicates few burbot inhabit the mine area.

Arctic Lamprey

Two Arctic lamprey, both less than 6 in., also were caught in the main stem within the proposed mine area, one each in May 1998 and August 1999. The life history of the fish is largely unknown, but is likely quite variable from place to place (McPhail and Lindsey, 1970). Lampreys in interior Alaska are considered to be nonmigratory and also nonparasitic, with adults rarely reaching 12 in. (Morrow, 1980). Lampreys metamorphose from larvae that bury themselves in the soft mud of stream margins and backwaters. Because such habitat is much more prevalent in the lower river, lamprey use of the proposed mine area likely is marginal.

3.13.2 Shaw Creek

Shaw Creek is a 70-mile-long, typical brown water stream where flow is primarily derived from bogs producing tannic-stained water with high concentrations of dissolved organic compounds. Brown water streams have similar, yet gradual, swings in discharge as clear water streams, but generally have lower discharge in winter and usually freeze solid in their lower reaches (Reynolds, 1997). In late winter, the lower 28 miles of Shaw Creek has been found to be anoxic. Lower Caribou Creek, tributary to Shaw Creek and located 6 miles above its mouth, freezes solid (Ridder, pers. obs.). Open water areas are present during winter, however, in the drainage upstream of Gilles Creek approximately 40 miles above the mouth of Shaw Creek (Windsor, 1999). Although quality evaluations have not been done, aquatic habitat can be considered pristine for its type. The drainage is undisturbed, except for two winter roads with three stream crossings that access timber sales near Caribou and Rapids creeks.

Fish investigations by ADFG have involved limited surveys in Shaw Creek's lower 6 miles and the tributaries of Rosa, Keystone, Rapids, and Gilles creeks; annual harvest surveys; and an 8-year study of post-spawning grayling outmigrating from Caribou Creek. Other investigations by Teck-Pogo involved short ground or aerial surveys at proposed road crossings at the major Shaw Creek tributaries of Keystone, Caribou, and Gilles creeks, and of upper Shaw Creek. Most of the other tributaries crossed are either ephemeral or disappear into the bog surrounding the main stem (Hanneman, 2000f).

Ten fish species have been found in the lower 6 miles of Shaw Creek: grayling, slimy sculpin, round whitefish, burbot, humpback whitefish, least cisco, longnose sucker, northern pike, lake chub (*Couesius plumbeus)*, and juvenile silver salmon (*Oncorhynchus kisutch)* (Ridder, 1983). Because of a general lack of overwintering habitat, the majority of fish in the drainage likely overwinter in the Tanana River, although some may overwinter in the upper drainage. Grayling tagged in Caribou Creek and 28 miles upstream in Rapids Creek have been routinely recovered in the Tanana River in April prior to breakup of Shaw Creek (Ridder, 1991). At that time, the abundance of adult-sized grayling off Shaw Creek's mouth has been estimated to range from 6,000 to 21,000, and averaged 13,000 for the years 1981 through 1987 (Ridder, 1989; ADFG files). All ten species have been caught in Caribou Creek migrating upstream in mid- to late May (Ridder, 1984). Fish distribution and habitat use in the drainage, with the possible exception of grayling, are largely unknown.

Arctic Grayling

Grayling use of Shaw Creek parallels that of the Goodpaster with the exception of overwintering. Grayling enter Shaw Creek during breakup, which typically occurs the last week in April. They have been observed migrating up Caribou Creek, with burbot, the first of May in overflow over bottom-fast ice (Ridder, pers. obs.). Known spawning areas include the main stem up to river mile 20 and Caribou, Rapids, and Gilles creeks (Ridder, 1984, 1998a; Morsell, 2000). Estimated spawning abundance in Caribou Creek has ranged from 5,000 to 10,000, and averaged 7,000 fish from 1981 through 1987, making it the major spawning site in the drainage (Ridder, 1994).

After spawning, adult grayling migrate to feeding areas upstream in Shaw Creek and to other drainages. Shaw Creek grayling contribute to nine other Tanana River tributary fisheries stretching from the Delta Clearwater River to the Little Salcha River 60 miles downstream of Shaw Creek (Ridder, 1991). Grayling spawning in Caribou Creek contribute 70 percent to the fish found in the nearby Richardson Clearwater (Ridder, 1994). Tagged fish from Caribou Creek also have been recovered in Gilles Creek above the proposed all-season road crossing, and juveniles and young of the year have been recovered at the road crossing (ADFG field notes, 1983; Morsell, 2000). No grayling have been found in upper Caribou Creek, although juveniles and subadults have been captured at the proposed road crossing (ADFG field notes, 1983; Morsell, 2000).

The extent of upstream dispersal of post-spawning grayling may be limited in Keystone Creek and Shaw Creek by beaver dams. Extensive beaver activity was noted below the road crossings at Keystone and upper Shaw creeks (Morsell, 2000). No fish were captured or observed at the upper Shaw Creek site, despite favorable habitat. No ground survey was conducted at the Keystone Creek crossing, although habitat looked poor from the air. Grayling, burbot, sculpin, lake chub, and juvenile silver salmon have been found in lower Keystone Creek (ADFG field notes, 1982).

Fishing effort and harvest in Shaw Creek are largely restricted to its lower 3 miles due to the creek's small size and numerous log jams. From 1990 to 1999, effort has averaged 612 person-days with an average harvest of 519 fish, principally grayling (n = 328) and burbot (n = 154), but including northern pike and whitefish (Parker, 2000a). Prior to a spring fishing closure begun in 1987, grayling harvests averaged 2,000 fish.

3.14 Wildlife

This section describes the affected environment for nonthreatened, endangered, and sensitive species. Threatened, endangered, and sensitive species are discussed separately in the following section (3.15).

3.14.1 Habitat Values

Jorgenson *et al*. (2000) used a method based on a geographic information system (GIS) for integrating habitat information for a large group of key species to assess wildlife habitat in the proposed project area, covering approximately 695,000 acres from the confluence of Shaw Creek with the Tanana River in the southwest to the upper Goodpaster River north of Shawnee Peak in the northeast. In the methodology, habitat use by 32 key species and groups (21 birds species, 9 mammals, and 2 groups of small mammal species, microtine rodents, and shrews) was selected to represent the broader range of species that occur within the project area. The methodology accounted for rare or sensitive species, harvested species, overall use of habitats by different species, and habitat rareness. It also computed a Conservation Priority Index intended to identify habitats that are in themselves rare and also important to wildlife, particularly for rare or sensitive species.

This habitat assessment methodology yielded a detailed map of 23 wildlife habitat classes in the project area (Figure 3.10-1). The most abundant habitats were lowland needleleaf forest (16.4 percent of total area), upland broadleaf forest (10.0 percent), upland mixed forest (25.4 percent), and upland needleleaf forest (11.8 percent), accounting in total for approximately 64 percent of the area. Nine habitats each composed less than 1 percent of total area: riverine barrens, riverine scrub, riverine broadleaf forest, lakes and ponds, lowland wet meadow, bluff meadow, cliff, alpine meadow, and human-modified habitats (predominantly farmland on the southern edge of the study area). Two habitats, bluff meadow and cliff, were exceedingly rare, composing less than 0.1 percent of total area (Jorgenson *et al*., 2000).

Six integrated habitat value indices that may be of use for land management decision-making purposes were developed. Because of the nature of the indices, depending on the management issue, the use of one or more of these indices to determine "high-value" wildlife habitat becomes very much an issue of which species are being considered and what value judgments or management imperatives are placed on them. For the purposes of this EIS, the Conservation Priority Index appeared to be the most useful metric for identifying priority habitats for protection from habitat-altering activities. A detailed explanation of the methodology is beyond the scope of this EIS; however, a description of the Conservation Priority Index is contained in Appendix A.3.

Jorgenson *et al.* (2000) developed a priority index of habitat conservation that combined habitat rareness with habitat use, with emphasis on use by rare species. High-priority rankings were calculated for cliff, riverine broadleaf forest, riverine mixed forest, lowland meadow, lowland broadleaf forest, and lakes and ponds, because these habitats were uncommon, important to rare species, or had overall high value for wildlife. In contrast, low-priority rankings were calculated for alpine dwarf scrub, subalpine needleleaf woodland, upland tall scrub, and lowland low scrub because these habitats had either low use or were relatively abundant habitats. When values of the Conservation Priority Index were categorized into high, medium, and low, high-priority areas covered 5 percent of the Pogo project area, medium-priority areas covered 70 percent, and low-priority areas covered 25 percent. Figure 3.14-1 presents a graphic representation of the habitat Conservation Priority Index.

3.14.2 Birds

Many species of birds are found in the Pogo project area, including loons and grebes, waterfowl, raptors, grouse and ptarmigan, shorebirds, woodpeckers, and passerines. Burgess *et al.* (2000) lists 122 bird species that are confirmed or likely to occur in the project area. Most bird species that breed in interior Alaska are migratory and are present only during the spring and summer months; a relatively small number are permanent residents that occur year-round. Before and after the breeding season, the Tanana River Valley (including the project area) is an important spring and fall migration corridor, and more than 200,000 birds pass through the region each spring and fall (Kessel, 1984; Cooper *et al.,* 1991; Anderson *et al*., 2000). The following discussion has been taken from a more detailed description of birds in the project area by Burgess *et al.* (2000).

Waterbirds

The Shaw Creek Flats are important for both migrating and breeding waterbirds (Ritchie, 1980; Ritchie and Hawkings, 1981). Species of waterbirds that probably breed in the Shaw Creek Flats and Quartz Lake areas include Common and Pacific loons, Horned and Red-necked grebes, Trumpeter Swans, Canada Goose, Green-winged Teal, Mallard, Northern Pintail, Northern Shoveler, American Wigeon, Canvasback, Greater and Lesser scaup, Surf and White-winged scoter, Common Goldeneye, Bufflehead, Common and Red-breasted mergansers, Lesser Yellowlegs, Solitary and Spotted sandpipers, Common Snipe, Bonaparte's and Mew gulls, and Arctic Terns.

The Goodpaster River and its major tributaries also are used by breeding waterbirds, including Harlequin Ducks, Trumpeter Swans (a pair regularly occupies wetlands in the southwestern corner of the Pogo claim block), Common and Red-breasted mergansers, and other dabbling and diving ducks (Burgess *et al.,* 2000).

- **Ducks** Dabbler as well as diving ducks frequent the lakes, ponds, and sloughs of Shaw Creek Flats and the Goodpaster River Valley. A May 2000 project-related survey showed that overall densities of ducks in the Goodpaster Flats (17.9 ducks/sq mi) were approximately a quarter of the densities found in the Shaw Creek Flats (70.7 ducks/sq mi). From a regional perspective, the Shaw Creek Flats area generally was characterized by somewhat lower densities of dabbling ducks and large diving ducks (scoters, Ring-necked ducks, and mergansers) compared to USFWS surveys across the Tanana and upper Kuskokwim basins, and higher densities of small diving ducks (Bufflehead and goldeneyes).

- **Trumpeter Swans** Trumpeter Swans nest primarily in open meadows in or near wetlands and rear their broods on open water in lakes and medium-sized ponds, typically with some amount of emergent vegetation on shorelines, especially when the cygnets are small.

  From a habitat perspective, lakes and ponds were considered essential for swans because of their use as brood-rearing habitats. Lowland meadows were considered high-use areas because of their use as nesting habitat, while rivers and streams and lowland low scrub were considered as low use areas. All other habitats were considered to be of negligible importance for swans.

  Figure 3.14-2 presents Trumpeter Swan sightings during surveys in 1995 and 2000. Eighty-two adults and 9 young in 5 broods were counted at 42 locations in the project area in 2000. All but seven sightings and one brood that were seen in the Goodpaster River Valley were located in the Shaw Creek Flats. Historical survey data indicate an expanding population of swans in the project area for both number of breeding pairs and number of flocks (nonbreeders). The number of broods observed in the area, however, has increased only slightly, from 2 in 1985 to 7 in 1995 and 5 in 2000 (Burgess *et al*., 2000).

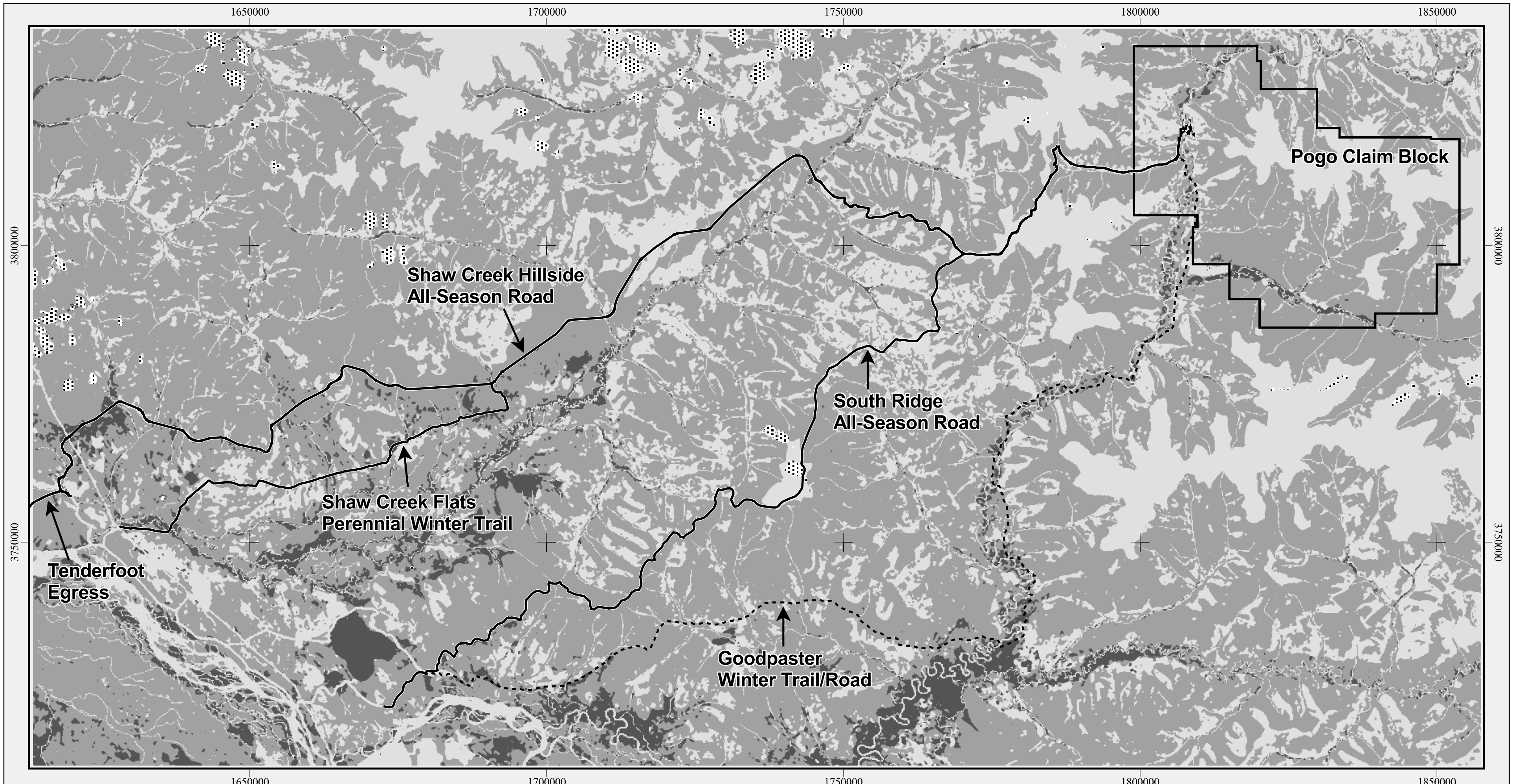
Raptors

Sixteen species of raptors probably occur in the project area (Bald and Golden eagles, Northern Harrier, Sharp-shinned Hawk, Northern Goshawk, Red-tailed Hawk, Rough-legged Hawk, American Kestrel, Merlin, Peregrine Falcon, Gyrfalcon, Great-horned Owl, Northern Hawk Owl, Great Gray Owl, Short-eared Owl, and Boreal Owl), and all of these species, except the Rough-legged Hawk, are likely to breed in the area (Burgess *et al*., 2000). Most of these raptors migrate south during the winter, but some are resident year-round. Important habitats for raptors include specific cliffs traditionally used for nesting (used by Golden Eagles, Peregrine Falcons, and Gyrfalcons) and traditionally used tree nests (used by Bald Eagles, Northern Goshawks, Red-tailed Hawks, and Great-horned Owls).

Some species are highly adapted to and dependent on forested habitats (e.g., Sharp-shinned Hawk, Northern Goshawk, Great Gray Owl, and Boreal Owl), others prefer open habitats of tundra, marsh, or grassland (e.g., Northern Harrier, Rough-legged Hawk, Short-eared Owl). The Gyrfalcon, Great Gray Owl, and Boreal Owl have been identified as priority species in central Alaska by the Boreal Partners in Flight Working Group primarily because of their biogeographic regional importance (i.e., they are restricted to boreal habitats). Eagles, Northern Goshawks, and Peregrine Falcons are discussed in greater detail under species of concern in Section 3.15 (Threatened, Endangered, and Sensitive Species).

Other Species

There are many passerine and other non-waterbird or raptor species found in the Pogo project area. Generally, these species occur in appropriate habitats throughout the project area. A more detailed description of these species may be found in Burgess *et al.* (2000). Species considered threatened, endangered, or sensitive are discussed in the following section (3.15).



Habitat Value Index

Conservation Priority

- Low
- Medium
- High
- Cloud and Shadow

2 0 2 4 6 8 Kilometers

1 0 1 2 3 4 5 Miles

N W E S

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-1
Habitat Conservation
Priority Index

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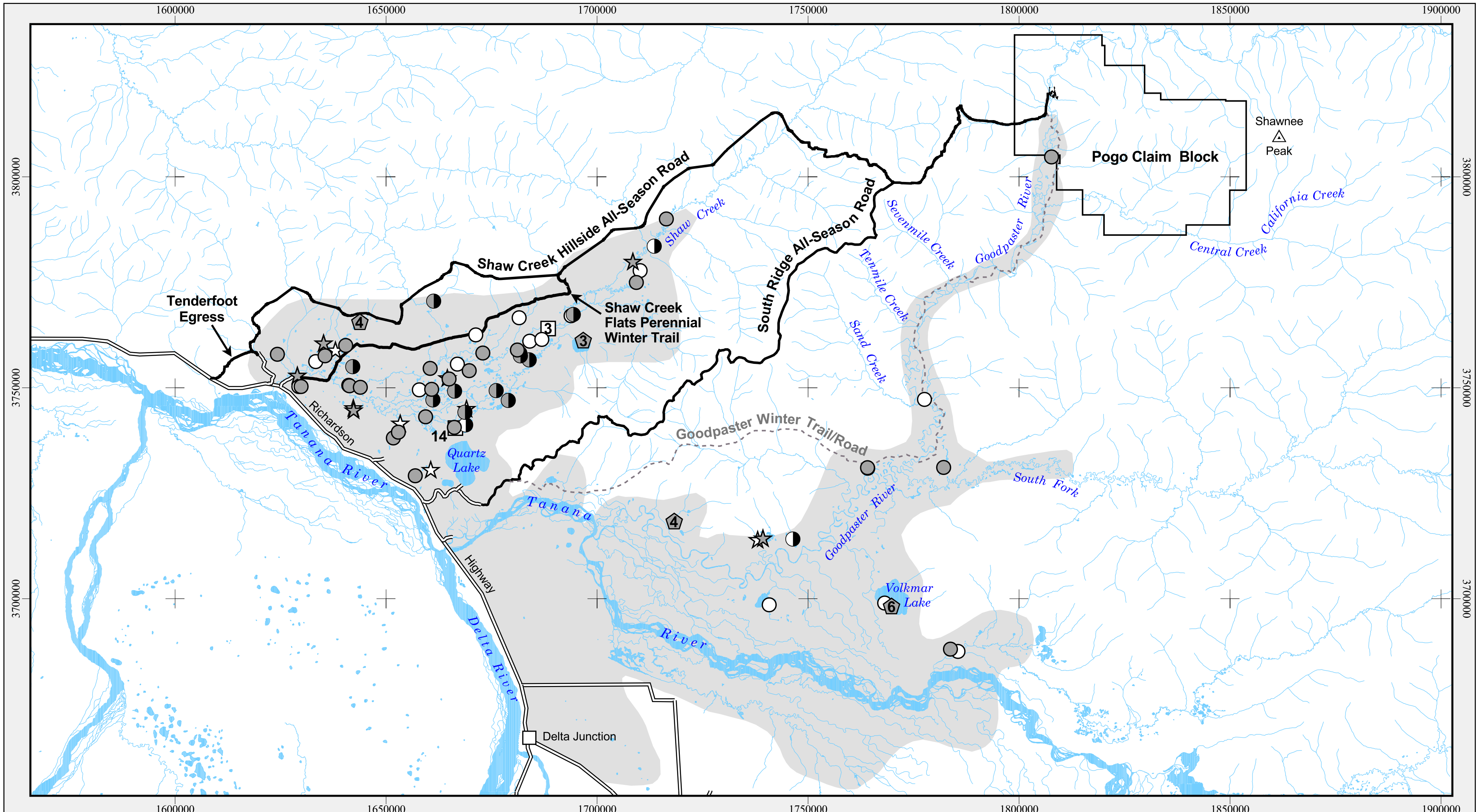
25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr



Legend

1995 Survey		2000 Survey
○	Pair	●
☆	Brood	★
◑	Single	◑
#	Flock Size	#

General Swan Survey Area

5 0 5 10 15 Kilometers
2 0 2 4 6 8 Miles

N S W E

1995 data from Alaska Trumpeter Swan Atlas
(Conant et al. 1996)
Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-2 Trumpeter Swan Sightings, 1995 and 2000

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26 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wildlife.apr

3.14.3 Mammals

Jorgenson *et al.* (2000) list 47 species of mammals that are confirmed or likely to occur in the vicinity of the project area. Many of these species are important to local residents, subsistence users, and recreationists. The project area is within the northern portion of Game Management Unit (GMU) 20D. The following discussion of major species has been taken from a more detailed description of mammals in the project area by Burgess and Lawhead (2000).

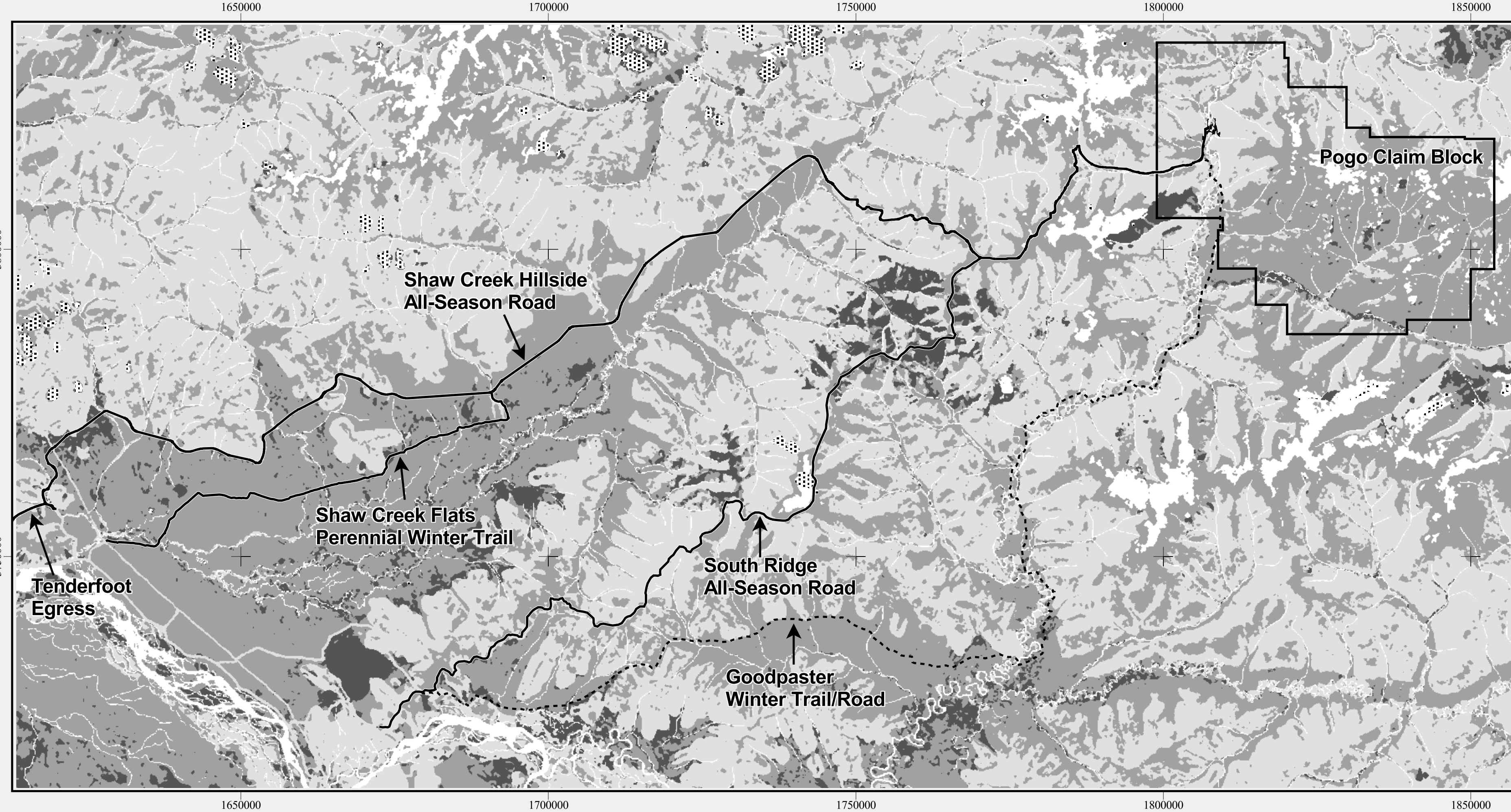
Moose

Moose occur throughout the project area. Moose populations in interior Alaska generally are not limited by habitat availability or quality, but rather by winter weather and predation (Gasaway *et al*., 1983; Boertje *et al*., 1996). During the course of a year, moose may be found at all altitudes, including high elevations which contain some of the highest quality moose habitat in the project area. Burned areas are important moose habitats from several years following the burn (after willows have colonized) until shrub cover begins to be replaced by taller trees (about 25 years following most burns in interior Alaska). Lakes and ponds with emergent or submergent vegetation are important spring and summer habitats, and higher elevation woodlands and tall scrub are important during late summer and winter.

Hunting, accidental mortalities (e.g., vehicle collisions), and habitat quality also influence moose populations to varying degrees. Because much of GMU 20D is relatively remote, hunting pressure is concentrated in the unit's more easily accessible southern portion in the vicinity of Delta Junction and the Richardson Highway (DuBois, 1996); however, the Goodpaster River Valley downstream of Tibbs Creek is a major hunting area (Fogels, 2003). In 1995, the state legislature mandated intensive management of moose for human consumption in large areas of the state, and GMU 20D was one of the areas in which this became the primary management goal. A wolf control program was approved to assist in reaching the population target, but has not yet been implemented. The moose population in GMU 20D in fall 1999 was estimated at 4,900 to 7,200 animals. Calf survival and yearling recruitment into the breeding segment of the population remain relatively low in northern GMU 20D.

From a habitat perspective, high use habitats for moose were considered to be riverine scrub, riverine broadleaf forest, lakes and ponds, lowland broadleaf forest, and upland tall scrub (Figure 3.10-1). Other habitats were ranked as medium or low use. Figure 3.14-3 presents moose habitat values in the project area. Moose concentration areas in the project area include calving habitats in the Shaw Creek Flats and wintering areas in the Central Creek burn area, which covers much of the Pogo claim block. The Salcha River drainage, north and west of the project area, contains much more extensive moose concentration areas used for calving, rutting, and wintering.

Within the project area are two locations where ADFG has historically conducted population surveys. The Central Creek trend area encompasses approximately the southeastern two-thirds of the Pogo claim block north of Central Creek. The purpose of this count is to provide information on long-term changes in moose population status. The Shaw Creek survey area encompasses almost all of the Shaw Creek Valley. The purpose of this count is to calculate a population estimate for the survey area.



Habitat Value
Moose

- Negligible
- Low
- Medium
- High
- Cloud and Shadow

2 0 2 4 6 8 Kilometers
1 0 1 2 3 4 5 Miles

N S E W

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-3
Moose Habitat Values

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In the Central Creek trend area, the 1998 survey found 29 moose and the 1999 survey found 61 moose. These findings compared with 118 to 139 animals per year in 1992–1994 (Burgess and Lawhead, 2000). In both 1998 and 1999, the numbers of moose counted were substantially lower than were recorded by ADFG in the Central Creek burn in the early 1990s. The mean density for the count area was 0.7 and 1.5 moose/sq mi in 1998 and 1999, respectively. These densities, although higher than average across all of GMU 20D, suggest a decline either in use of the area or in the moose population from the early 1990s. It is likely that the Central Creek area is less attractive to wintering moose because of declining habitat quality in the burn.

In general, moose density declines in burns more than 15 to 20 years old (Peek, 1997) as foraging opportunities decrease.

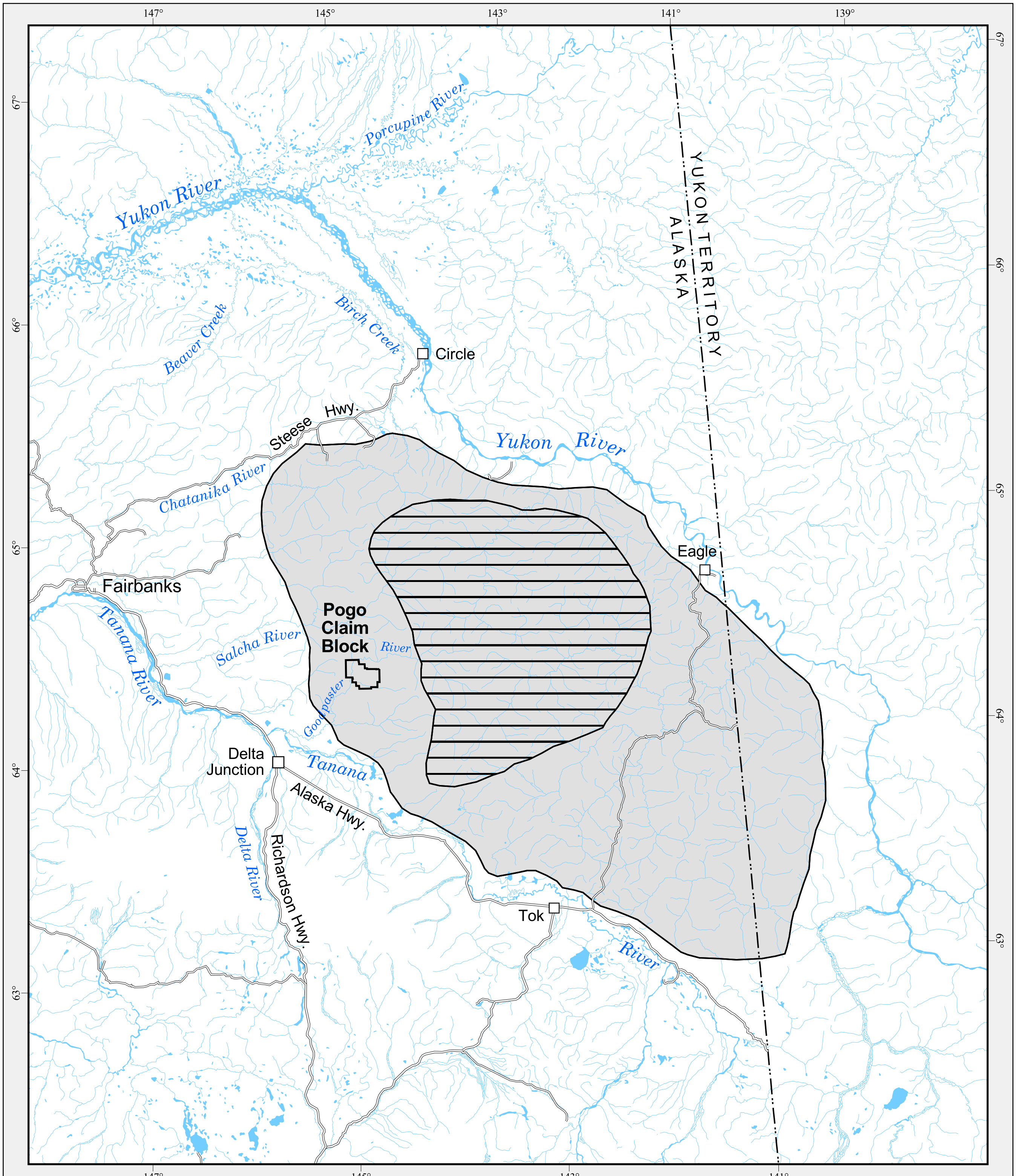
In the Shaw Creek Valley, moose were distributed throughout the survey area at relatively low density. The population estimate was 119 moose, which equated to a density of 0.4 moose/sq mi over the entire area. In interior Alaska, ≤0.6 moose/sq mi is considered low density, and >1.2 moose/sq mi is considered high density (DuBois and VerHoef, 1999). The highest densities of moose in the Shaw Creek survey area occurred in subalpine habitats and in areas burned by the Rapids Creek wildfire in 1986. The lowest densities occurred on the Shaw Creek Flats and in spruce forest habitats, whereas hillsides with birch and aspen forests had intermediate moose densities.

In northern GMU 20D, the number of moose harvested has remained relatively constant since 1984, averaging approximately 48 for all units annually (Burgess and Lawhead, 2000). More than 68 percent of that annual harvest occurred in the Shaw Creek drainage (approximately 18 moose per year), in the lower Goodpaster River (approximately 9), and in the upper Goodpaster River (approximately 6 per year). Goodpaster River Valley moose harvests have increased since 1992, however; harvests in uniform coding units (UCU) 300 (nonspecific Goodpaster River), 301 (lower Goodpaster River), 302 (upper Goodpaster River), and 303 (Eisenmenger Fork) have averaged 28 moose/year by an average of 114 hunters/year (Fogels, 2003).

Caribou

Caribou in the vicinity of the project area are considered members of the Fortymile Caribou Herd. The herd's range is bounded on the north by the Yukon River and Steese Highway, on the south by the Tanana River, on the west by Chena Hot Springs, and on the east by Dawson, Yukon Territories, Canada (Figure 3.14-4). The Pogo claim block and the northeastern half of the project's potential access corridors are located within the southwestern portion of the current annual range of the Fortymile Herd. The project area is southwest of the herd's current summer range, and calving concentration areas lie well to the north and east of the Pogo claim block in higher elevation areas. The project area is classified primarily as winter range (ADFG, 1986; U.S. Air Force [USAF], 1995).

Marked historical declines in the size and range of the herd have stimulated great interest in its welfare in recent years, culminating in the formation of the Fortymile Caribou Herd Planning Team (FCHPT), a diverse group of Alaska and Yukon residents and agency representatives who have shaped management actions on both sides of the border. During the early 1900s, the Fortymile Caribou Herd was thought to be the largest herd in Alaska and among the largest in the world. In 1920, Olaus Murie estimated the herd size at 568,000 caribou (FCHPT, 1995), with a range from Whitehorse in the Yukon Territory to the White Mountains north of Fairbanks.



Fortymile Caribou Herd

Total Range

Summer Range

N
W E
S

20 0 20 40 60 80 Kilometers

10 0 10 20 30 40 50 Miles

Caribou herd data from ADF&G.
Map base: US DMA DCW
Projection: UTM Zone 6; Datum: NAD 27

Pogo Mine EIS

Figure 3.14-4
Fortymile Caribou Herd Range

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19 August 2002

ABR File: Pogo_PDEIS_Ch3_Wildlife.apr

By the 1930s, the herd had declined to 10,000 to 20,000 caribou. Following this decline, the herd has rarely used the eastern part of its range in the Yukon Territory. By the mid-1950s, the Fortymile Herd had increased to near 60,000 and remained between 40,000 and 60,000 into the early 1960s (FCHPT, 1995). The herd often used areas east of Dawson and, in some years, the entire herd wintered in the Yukon Territory.

Between 1963 and 1973, the herd declined precipitously, from 50,000 to 6,500 animals. A combination of factors contributed to this crash and prevented recovery including, over harvesting by humans in 1964–1967 and 1971–1972, unfavorable winter weather (1966–1969 and 1971), and high wolf numbers (1963–1975). In 1967, Fortymile caribou ceased crossing the Steese Highway, and after 1973 rarely moved into the Yukon Territory (FCHPT, 1995).

Between 1976 and 1990, the herd grew to approximately 22,000, but by 1990 herd growth had ceased. Public concern over the condition of the herd stimulated development of a joint management plan to focus the cooperative efforts of agencies and citizens of both the Yukon Territory and Alaska (FCHPT, 1995). The goal of the plan is to stimulate further growth of the herd and to restore the herd to its previous range in both Alaska and the Yukon. The management plan and related research have received a high degree of public scrutiny, and the research was reviewed favorably by 10 independent, international scientists familiar with wolf biology and predator–prey relationships.

From 1990 to 1995, herd size remained stable at approximately 22,000 caribou. After that period of relative stability, implementation of the management plan coincided with an increase in herd size, estimated at 31,029 caribou in June 1998 (Boertje and Gardner, 1999) and approximately 33,000 by spring 2000. In the fall of 2002 the herd numbered approximately 45,000 (Fogels, 2003). Increases have resulted from a rise in pregnancy rates and improved calf and adult survival. They have been attributed to both reduced predation and favorable environmental conditions.

ADFG has monitored the locations of radio collared female caribou of the Fortymile Herd since late 1991. Radio locations confirm that the Pogo claim block lies southwest of areas used by radio collared female caribou of the Fortymile Herd during the six-month period April through September period. During the autumn and winter seasons, however, range use by the Fortymile Herd is at its maximum and the Pogo claim block lies in an area that has been used by a portion of the herd during 4 to 5 of the last 8 years. Use of the project area probably will increase as herd size increases because the area contains a mosaic of habitat types offering preferred forage species throught out the year (Fogels, 2003). During all other seasons since 1992, radio-collared female caribou were not observed in the Pogo claim block. During calving and post-calving, radio collared female caribou were concentrated in areas more than 25 miles east and northeast of the Pogo claim block (Burgess and Lawhead, 2000).

Incidental observations of caribou by the Applicant's personnel and contractors, as well as tracks seen by ADFG during aerial surveys, tend to confirm that the project area receives light use by small numbers of caribou throughout the year. There has been little indication of any substantial use of the Pogo project area by the herd, however.

Because of their prodigious migrations, caribou can be located in a wide range of habitat types, but the most used habitats in interior Alaska tend to be located at higher elevations in open alpine habitats, particularly during calving, and in open woodlands. From a habitat perspective, alpine meadow, subalpine needleleaf woodland, and alpine dwarf scrub were perceived as areas receiving high use by caribou. Lowland needleleaf forest, upland needleleaf woodland, upland needleleaf forest, and upland north-facing needleleaf forest (all of which tend to have a large component of open canopy) were ranked as medium use, and most other non-aquatic habitats were ranked as low use. Figure 3.14-5 presents caribou habitat value in the project area.

Since 1993, all caribou harvest in the Pogo project area has occurred in the upper Goodpaster River and Eisenmenger Fork UCU. The Pogo claim block lies within the upper Goodpaster UCU, and Eisenmenger Fork UCU lies approximately 15 miles due east of the Pogo claim block. From 1993 to 1998, inclusive, an average of four caribou were taken annually in each of the upper Goodpaster and Eisenmenger Fork UCUs (Burgess and Lawhead, 2000).

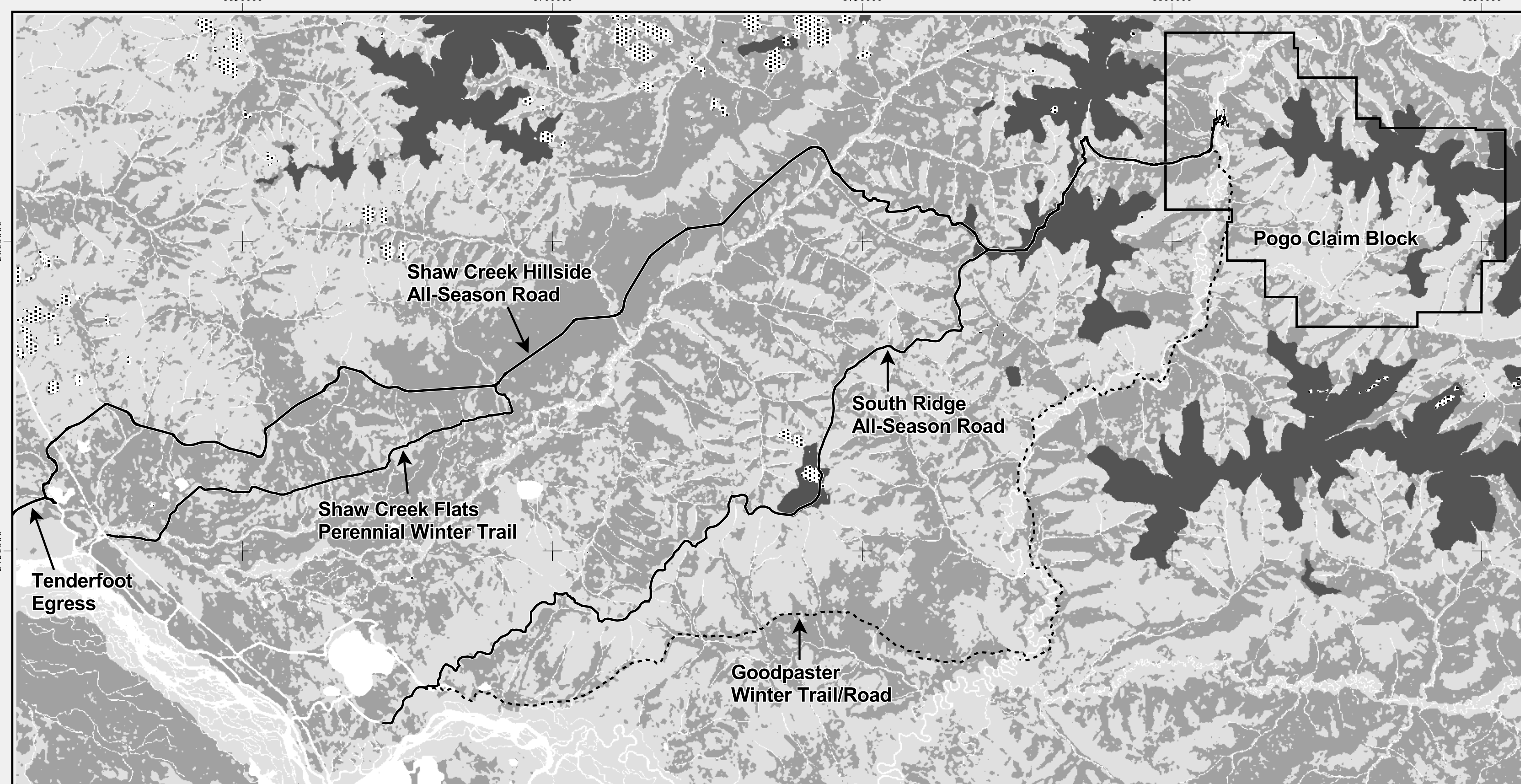
Brown Bear

Brown bears, as well as black bears, are present in the Pogo project area and both have been observed occasionally by project workers around both the surface and advanced exploration camps during summer. Bear populations north of the Tanana River in GMU 20D are considered to be naturally regulated because of low human-induced mortality (Hicks, 1995b). Brown bear habitat in northern GMU 20D comprises the terrain at both lower and higher elevations in the Shaw Creek and Goodpaster River headwaters, where hunter access is more limited.

Brown bears can be found in a variety of habitats, and they tend to exhibit strong seasonal habitat preferences, which often are specific to localized food sources in different regions. In general, brown bears in interior Alaska prefer high-elevation, open alpine habitats in most seasons and they tend to avoid low-elevation closed forests. The following habitats in the project area were considered as high use for brown bears: upland north-facing needleleaf forest, alpine meadow, subalpine needleleaf woodland, and alpine dwarf scrub. Other upland habitats were considered as medium use and non-aquatic lowland and riverine habitats are ranked as low use. Figure 3.14-6 presents brown bear habitat values in the project area.

There are no brown bear concentration areas in the Pogo claim block or in the larger Pogo project area (ADFG, 1986). Spring concentration areas and berry use concentration areas occur at high elevations in the headwaters of the Salcha River to the north and in the South Fork and Volkmar River tributaries to the east. Brown bears, however, have been observed feeding on chinook salmon in the Goodpaster River. Salmon streams are important to interior brown bears, and as the chinook salmon run increases in size this resource will become increasingly important to the bears (Fogels, 2003).

The earliest brown bear population estimate in 1991 was 92 to 109 bears 2 years of age or older in northern GMU 20D (Abbott, 1991). The most recent estimate, in 1992–1994, was 105 to 124 total bears in GMU 20D north of the Tanana River (Hicks, 1995b).



Habitat Value
Caribou

- Negligible
- Low
- Medium
- High
- Cloud and Shadow

2 0 2 4 6 8 Kilometers
1 0 1 2 3 4 5 Miles

N W E S

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

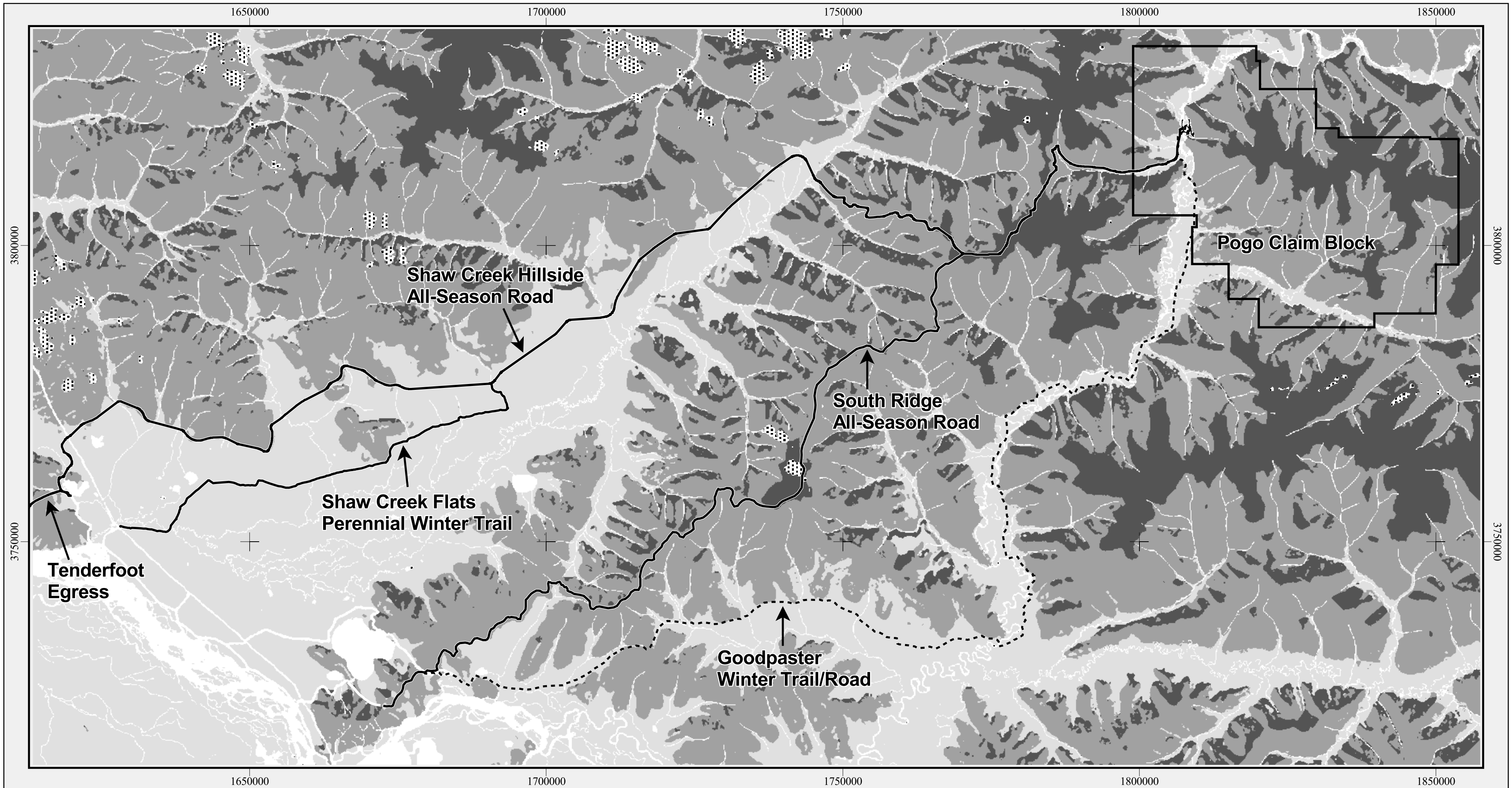
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-5
Caribou Habitat Values

ABR inc. environmental research & services

25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr



Habitat Value
Brown Bear

- Negligible
- Low
- Medium
- High
- Cloud and Shadow

2 0 2 4 6 8 Kilometers

1 0 1 2 3 4 5 Miles

N
W E
S

Map derived from supervised image classification of Landsat TM satellite image, 10 August 1994.

Projection: Alaska State Plane Zone 3 (units ft.); Datum: NAD 83

Grid: 50,000 feet

Pogo Mine EIS

Figure 3.14-6
Brown Bear Habitat Values

ABR inc. *environmental research & services*

25 July 2002 | ABR File: Pogo_PDEIS_Ch3_Habs.apr

Between 1981 and the early 1990s, the management objective in GMU 20D was to provide a stable population with a mean annual harvest of 30 bears. In the early 1990s, harvest was liberalized in northern GMU 20D in an attempt to increase moose productivity (Abbott, 1993a). North of the Tanana River, the management objective was to increase the mean annual harvest to 3 to 10 percent of the bear population until moose calf survival increased to greater than 30 calves per 100 cows for 3 consecutive years. Since 1996, the objective has been to manage bears to maintain an annual harvest of 5 to 15 bears, with 60 percent of the harvest comprising males. Attempts to increase harvest in northern GMU 20D have been moderately successful with mean annual harvest increasing from 1 bear per year to 3 bears per year and the range of annual harvest increasing from 0–2 bears per year to 1–7 bears per year in the last 7 years with more liberal hunting regulations. Harvest was probably not high enough to cause a population reduction, but as the number of hunters increase, bear harvest is also expected to increase and could exceed sustainable yield (Fogels, 2002).

Between 1989 and 1998, annual harvests north of the Tanana River in GMU 20D have ranged from none to seven. During that 10-year period a total of seven bears was harvested in the lower Goodpaster UCU, while eight bears were taken from the upper Goodpaster UCU, with only three bears taken in the Shaw Creek UCU. Thus, an average of less than one bear was harvested annually in each of these UCUs. Approximately 40 percent of the total harvest north of the Tanana came from the Tanana River lowlands UCU accessible from the river, which undoubtedly reflects the distribution of the human population more than that of the bear population. Because of the low reproductive rate for bears, bear populations are sensitive to overharvest and mortality from hunting generally limits population size in accessible areas (Burgess and Lawhead, 2000).

Two characteristics make bears a particular concern in project planning and management: their very low reproductive rate, which makes populations vulnerable to depletion, and their attraction to and ready habituation to human activities, primarily when a food source is accidentally or deliberately made available (Milke, 1977; Follmann *et al*., 1980).

Black Bear

Black bears are distributed throughout the project area, except in treeless alpine habitat favored by brown bears (Hicks, 1996). In GMU 20D black bears are near the northern limit of their range in Alaska.

During spring, black bears in the Pogo project area use moist lowlands where early growing vegetation forms the bulk of their diet (Hatler, 1967). In the fall, they feed primarily on berries found in open meadows or alpine areas. The following habitats in the Pogo project area were considered as high use for black bears: riverine scrub, lowland broadleaf forest, lowland needleleaf forest, and upland broadleaf forest. Aquatic habitats, bluff meadows, cliffs, and alpine habitats were considered to have negligible use, and other habitats were considered as low or medium use by black bears.

Accurate estimates of black bear population size are not available for GMU 20D. However, Hechtel (1991) reported 17.5 adult black bears/100 sq mi in the Tanana Valley. Extrapolation of this density estimate to other portions of GMU 20 resulted in a population estimate of 525 bears north of the Tanana River in GMU 20D (Abbott, 1993b; Hicks, 1996). In the last two decades, black bear populations have been considered stable at moderate densities in GMU 20D (Townsend, 1986). Black bear mortality in this area results from human harvest (legal, illegal, and defense of life and property kills), predation by brown bears, food shortages that affect cub and yearling survival, and flooding of winter dens (Alt, 1984; Hicks, 1996).

Seasons and bag limits for black bear in GMU 20D have not changed since the late 1970s: There is no closed season and the bag limit is three per year. Between 1990 and 1995, the management objective north of the Tanana in GMU 20D was for a harvest of 15 black bears (Abbott, 1993b; Hicks, 1996). In 1995, this objective was changed to allow 35 black bears to be harvested annually (Hicks, 1997c, 1999b).

Most bear harvests in GMU 20D occurs near the road system south of the Tanana River along the Richardson Highway and along major river systems (Hicks, 1996). Total hunter take of black bear in GMU 20D north of the Tanana River has ranged from 2 to 12 between 1987 and 1996, and averaged 5.5 annually, well below the management goal.

During the 9-year period from 1989 through 1998, a total of 11 bears was harvested in the lower Goodpaster UCU, 6 bears were taken from the upper Goodpaster UCU, and 34 bears were taken in the Shaw Creek UCU. Thus, only in the Shaw Creek UCU, with an annual average harvest of four black bears, was an average of more than one bear harvested per year.

Wolf

Gray wolves are present in the Pogo project area and throughout GMU 20D at all times of year, where their primary prey are moose, caribou, and Dall sheep. Wolves have been observed occasionally by the Applicant’s personnel and contractors, as reported on wildlife observation forms. One or two packs have been known to range in the project area in the past (Valkenburg and Davis, 1989), and the area now includes two or three permanent packs, with the possibility of additional single or paired wolves (Fogels, 2003). An active den was located in the vicinity of Indian Creek in summer 1998, and as many as 17 wolves were associated with that pack, presumably including pups produced that year at the den (Burgess and Lawhead, 2000).

Wolves are habitat generalists, having few habitat requirements, except that their ranges support adequate populations of prey. For denning, wolves do require well-drained sites with soils suitable for excavation of dens. Adequate sites are unlikely to be limiting to wolves in any area of their range.

Since the early 1900s, wolf populations in the region have fluctuated widely, largely in response to wolf control programs. In the late 1940s and early 1950s, wolves in interior Alaska, as in most other parts of the state, were numerous, but by the late 1950s were reduced to low numbers due to federal wolf control programs (Gasaway *et al*., 1983).

Wolf control ended in 1960, and the population in GMU 20D increased to 200 to 250 animals, (Hicks, 1997a). Because these numbers were considered to be high, a wolf control program was authorized in 1979 in response to decreases in moose abundance that began in the mid-1960s (ADFG, 1984). This control program included aerial shooting permits issued to the public by ADFG. From fall 1979 to spring 1983, 105 wolves were removed from GMU 20D by trappers, ADFG staff, and aerial hunters. The wolf control program ended in 1983, and all harvest since has been conducted by hunting and trapping.

In March 1995, the Alaska Board of Game established the still-current population goal of 15 to 125 wolves for GMU 20D, in view of the low caribou and moose populations and the state legislature’s mandate for intensive management of ungulates for human consumption as a priority management goal. The broad population range of the objective was intended to allow temporary reduction of the wolf population to low levels, if needed, to stimulate prey population increases. Also in 1995, the trapping season was extended and a wolf control implementation plan was adopted but never implemented (Burgess and Lawhead, 2000).

Efforts at wolf control in GMUs 20E and 20D during the late 1990s were stimulated in large part by public interest in growing the Fortymile Caribou Herd through intensive management action, as recommended by the FCHPT. These efforts included attempts to increase harvest by trappers within the range of the Fortymile Caribou Herd and a program to sterilize the alpha male and female and translocate other members of those packs believed to have the strongest effect on Fortymile caribou. Wolf harvest increased in the late 1990s as a result of renewed interest in wolf trapping, stimulated by a privately sponsored wolf harvest incentive program in 1995–1997 (the "Fortymile Caribou Calf Protection Program," which paid $400 per pelt for wolves from the Fortymile Herd's range). Since 1997, attempts to further reduce wolf numbers have included wolf relocation and sterilization programs. Since the mid-1990s, the distribution of harvest has shifted, largely as a result of interest in increasing the abundance of caribou in northern GMU 20D.Before that time, harvest was 70 to 80 percent from the southern portion of GMU 20D, south of the Tanana River. Since the mid-1990s, harvest has been more evenly divided between southern and northern GMU 20D (Burgess and Lawhead, 2000).

Despite efforts to increase wolf harvest, no substantial reduction in the autumn wolf densities has been detected (Boertje and Gardner, 1999). Autumn wolf densities in the annual range of the Fortymile Caribou Herd (including primarily GMU 20E and northern GMU 20D) have remained relatively stable at six to eight wolves/390 mi^2, although a slight decline was observed after winter 1995–1996, when 57 percent of wolves in those two units were harvested (Boertje and Gardner, 1999).

The most recent population estimate for GMU 20D was 116 to 128 wolves (Hicks, 1995a). The total harvest of wolves from GMU 20D, as estimated from sealing of pelts, was 15 wolves between 1 July 1998 and 30 June 1999 for north and south GMU 20D combined (Hicks, 1999a), down from 38 wolves harvested in 1997–1998 (16 from northern GMU 20D) (Hicks, 1998) and 28 in 1996–1997 (10 from northern GMU 20D) (Hicks, 1997b). Harvest of wolves in the Pogo project area from 1994 through 1998 was concentrated in the upper Goodpaster River UCU (40 wolves) and the Shaw Creek UCU (22) (Burgess and Lawhead, 2000). This concentration undoubtedly reflects the distribution of trapping effort more than the distribution of population size of wolves. In 1997–1998, six wolves from two packs in northern GMU 20D were relocated out of the unit as part of the Fortymile Caribou Management Plan (Hicks, 1998).

Furbearers

Twelve species of furbearers in the project area, excluding wolf, are regularly harvested by humans: wolf, lynx, beaver, muskrat, coyote, red fox, marten, short-tailed weasel, least weasel, mink, wolverine, and river otter. General information on abundance, from ADFG survey and inventory reports, and harvest statistics are available for the six species of furbearers, including wolves and lynx, whose harvested furs must be sealed. Population information is generally lacking for the other species.

ADFG manages the harvest of furbearers under both trapping and hunting regulations, and a representative must seal pelts of species considered sensitive to overharvest: lynx, beaver, river otter, wolverine, and wolf taken anywhere in Alaska and marten trapped in certain GMUs or subunits (not including GMU 20D). The primary purpose of sealing is to gather more detailed information about the harvest. ADFG manages harvest through adjustments to bag limits and seasons for each species in each GMU or subunit. The following descriptions have been taken from more detailed descriptions of furbearers in the project area by Burgess and Lawhead (2000).

Wolverine

Wolverines are wide-ranging carnivores that occupy forests and tundra throughout Alaska (Manville and Young, 1965; Pasitschniak-Arts and Larivière, 1995). Prey include small and large mammals, carrion, birds, eggs, and insects (Magoun, 1985; Pasitschniak-Arts and Larivière, 1995). Population densities of wolverines generally are low and home ranges between 190 and 230 sq mi (500 and 600 km^2) have been reported for males in Alaska (Magoun, 1985; Whitman *et al*., 1986). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), wolverines were considered by trappers to be scarce in GMU 20D. The number of wolverines harvested annually from GMU 20D ranged from 2 to 15 between 1986 and 1999. Wolverine pelts are prized for parka trim and cold-weather clothing. Wolverines tend to inhabit remote areas; habitat loss and human predation are the principal threats to their population (Hornocker and Hash, 1981).

Marten

Marten are restricted to forested areas throughout Alaska (Clark *et al*., 1987). Marten generally require coarse woody debris or trees to provide shelter and pathways under snow (Buskirk, 1983; Paragi *et al*., 1996). Marten diets are composed primarily of small mammals, but they use birds, fish, carrion, insects, fruits, and human food when available (Buskirk and MacDonald, 1984; Ben-David *et al*., 1997). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), marten were considered by trappers to be increasing from scarce to common in GMU 20D. Marten are relatively easy to trap and, depending on pelt prices, they are heavily exploited by trappers.

Mink

Mink inhabit the shores of streams, lakes, and coastlines of the boreal forest in Alaska (Larivière, 1999). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), mink were considered by trappers to be scarce in GMU 20D. Mink prey primarily on animals associated with water, including fish, terrestrial invertebrates, birds, and, to a lesser degree, small mammals (Harbo, 1958; Johnson, 1985).

River Otter

River otters are restricted to aquatic and shoreline habitats. They are not endangered, but are listed in Appendix II of the Convention on International Trade in Endangered Species (CITES), which requires permits for international sale of pelts, principally because of low populations in the contiguous 48 states. River otters feed on a variety of fish, marine invertebrates, and, less commonly, small mammals, birds, and eggs (Larsen, 1983). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), otters were considered by trappers to be scarce in GMU 20D. The number of river otters harvested in GMU 20D ranged from zero to six between 1986 and 1999.

Red Fox

Red foxes occur throughout Alaska, except south of the Chugach Mountains in the Prince William Sound area (Hall, 1981). Small mammals, birds, berries, and insects compose the bulk of the diet of the red fox (Samuel and Nelson, 1982; Eberhardt, 1977). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), red foxes were considered by trappers to be common in GMU 20D.

Beaver

Beavers occur exclusively in association with woody vegetation and fresh water, including streams and large rivers, impoundments and lakes, and even the alpine zone where aspen is available. In the project area, from a habitat perspective, lakes and ponds were identified as essential for beavers. Rivers and streams and lowland meadows were considered as medium use, and all other habitats were ranked as low or negligible use. In most areas, trapping is the main factor limiting the number of beavers per colony (Hill, 1982).

Muskrat

Muskrats are associated with aquatic environments, typically standing or slowly flowing waters containing vegetation, including fresh water marshes near lakes, sloughs, streams, and rivers (Perry, 1982). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), muskrat were considered by trappers to be common in GMU 20D.

Coyote

In general, coyotes are not abundant in Alaska and occur mainly in the southern portions of the state, especially in areas where wolves have been reduced or eliminated (Bee and Hall, 1956; Manville and Young, 1965; Hall, 1981). Coyotes are highly adaptable, denning in a variety of habitats and eating a wide variety of animal and plant foods (Bekoff, 1982). At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), coyotes were considered by trappers to be increasing from common to abundant in GMU 20D where they are more common south than north of the Tanana River.

Weasels

Ermine (short-tailed weasels) and least weasels are common throughout Alaska, from arctic tundra to coastal forest (Hall, 1981), but generally are not sought by trappers because of their small size and low commercial demand. They are predators primarily of voles and lemmings, although other small vertebrates and insects may also be consumed. At the time of the most recent Survey–Inventory Management Report on furbearers (Hicks, 1995a), weasels were considered by trappers to be increasing from common to abundant in GMU 20D.

3.15 Threatened, Endangered, and Sensitive Species

American Peregrine Falcon

The American Peregrine Falcon was removed from the endangered species list in August 1999, but it is still treated as a species of concern during the Section 7 consultation process under the ESA by the USFWS, and recovery will continue to be monitored closely for 5 years. This subspecies originally was listed as endangered after experiencing significant declines in population size and productivity, primarily due to pesticide contamination. Since the late 1970s, however, it has recovered over much of its range in Alaska (Ambrose *et al.*, 1988).

This species has recently begun to reoccupy areas after pesticide-induced, continent-wide declines in the 1960s and 1970s depleted their numbers on all rivers in interior Alaska (Ambrose *et. al.,* 1988). Since monitoring surveys in the vicinity of the proposed project were initiated by the USAF in 1994, the number of occupied sites in the Pogo project area has increased from two to six. Five cliff-nesting habitats were identified in the Pogo project area (Figure 3.15-1): Shaw Creek Bluff, Sevenmile Creek and the Goodpaster River, lower Central Creek, Indian Creek, and Glacier-Rock Creek (Burgess and Ritchie, 2000). During the 4-year period (1997-2000) during which Peregrine Falcon nesting surveys were conducted by the Applicant, occupied nests were observed in each of these habitats at least once, and all five are therefore considered to be Peregrine Falcon nesting habitat. This species is present in interior Alaska from late April until late September.

Northern Goshawk

The Northern Goshawk is considered a sensitive species across its range in Alaska. Although not protected under the ESA, resource management agencies encourage surveys for this species and their nest sites. In addition, goshawks have been surveyed during environmental assessment studies for other development projects in interior Alaska (Ritchie, 1981; Roseneau and Bente, 1981; Anderson *et al*., 1997).

The Northern Goshawk is a year-round resident of interior Alaska forests, preferring to nest and forage in deciduous and mixed forests. This species' abundance varies with population cycles of its principal prey species – snowshoe hare and grouse. Because hare abundance has increased over large areas of interior Alaska in the last few years, goshawk numbers are expected to increase accordingly. When prey numbers are low, suitable habitats and territories can go unoccupied for long periods. Therefore, nest surveys often identify many inactive nests. Figure 3.15-1 presents the results of Northern Goshawk surveys in 1999 and 2000 along potential access corridors and at the mine site (Burgess and Ritchie, 2000).

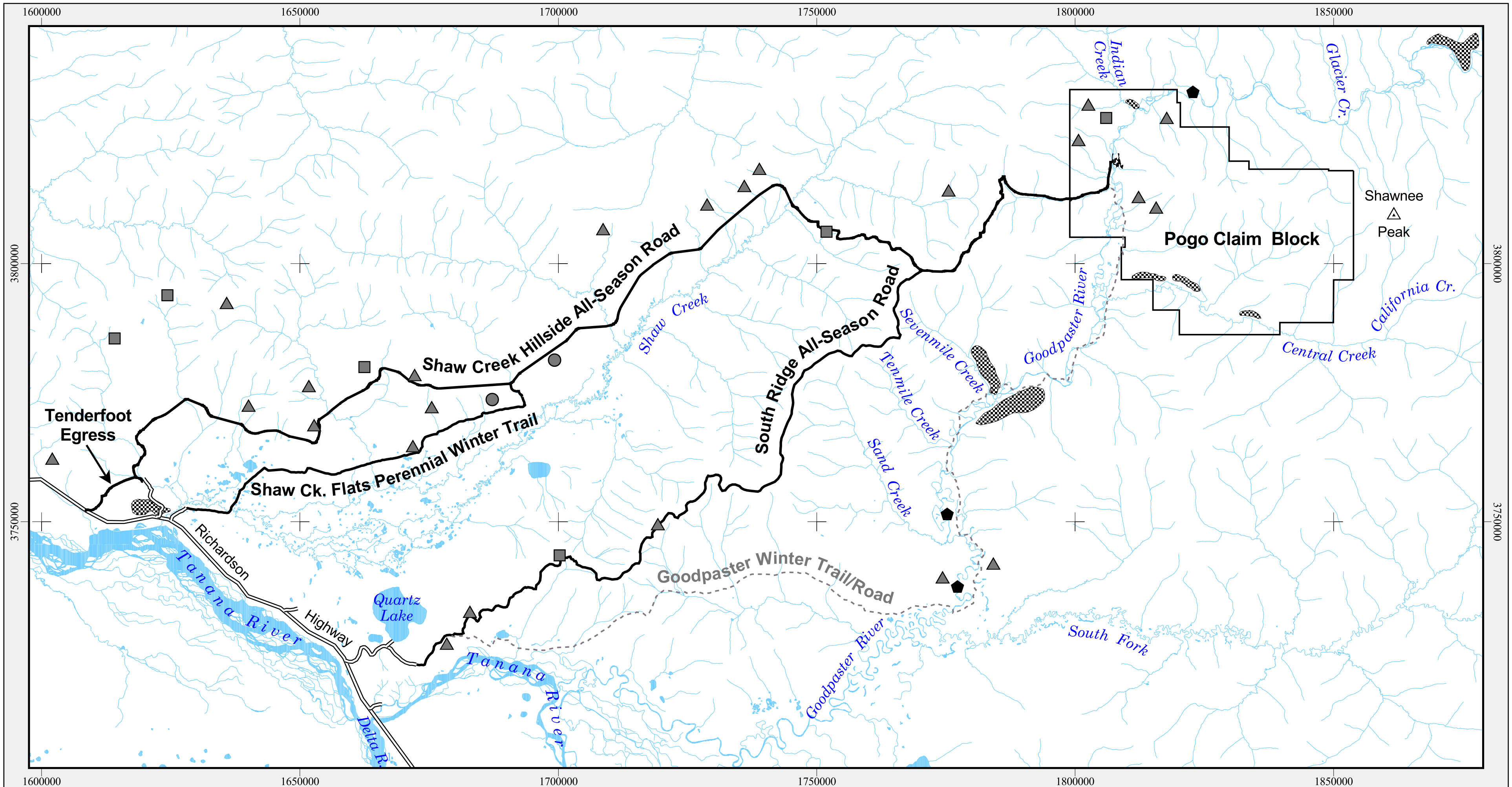
Bald Eagle

The Bald Eagle receives special protection under the Bald Eagle Protection Act, as does the Golden Eagle, because of its similarity of appearance. The Bald Eagle Protection Act prohibits the taking, harassment, or disturbance of eagles.

Bald eagles are present in interior Alaska, primarily during summer months, although they occasionally winter near open water areas in the Interior. The number of breeding pairs has increased along interior Alaska rivers in recent years (Ritchie and Ambrose, 1996), and there appears to be additional unoccupied, suitable habitat along the Goodpaster River and Shaw Creek. Only three nests, however, are known in the Pogo project area (Figure 3.15-1). One is approximately 2.5 miles northeast of the exploration camp, and the other two are located at least 12 miles away along the Goodpaster River near or below Sand Creek. No nests were identified along any of the potential surface access routes or in the Shaw Creek Flats (Burgess and Ritchie, 2000).

Harlequin Duck

The Harlequin Duck is considered a species of concern because it was formerly a Category 2 candidate species. Although the Harlequin Duck is not formally protected under the ESA, resource management agencies continue to encourage research and implementation of management practices that would stop population loss and alleviate threats to preclude the possible future need for listing.



Legend

Northern Goshawk Sites:
(may represent > 1 nest)

- ▲ Inactive 1999–2000
- ■ Active 1999
- ● Active 2000

⬟ Bald Eagle Nests

Cliff habitat

Note: 1997–2000 survey areas were based on conceptual access alternatives. Due to the sensitive nature of raptor cliff nest locations, nests are not shown. Specific site information can be obtained from the author.

N
W E
S

5 0 5 10 Kilometers

2 0 2 4 6 Miles

Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.15-1 Project Area Cliff-nesting Habitat, and Northern Goshawk and Bald Eagle Nest Sites

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26 July 2002 | ABR File: Pogo_PDEIS_Ch3_Wildlife.apr

This species breeds along swiftly flowing mountain streams in interior Alaska. It is present in the Interior from late spring until late summer. Although uncommon, they are likely to be found along suitable steam habitats undisturbed by human activities. A number of these habitats occur along the Goodpaster River and its tributaries, including Central and Indian creeks (Burgess and Ritchie, 2000).

Pairs of Harlequin Ducks were found at three locations in the Pogo claim block in 1997–2000: on the Goodpaster River between Indian and Liese creeks (1999), between Liese and Pogo creeks (1999, 2000), and on Central Creek near the mouth of Sonora Creek (1998, 1999) (Burgess and Ritchie, 2000). A single male was observed on the Goodpaster River near the mouth of Indian Creek in 1997. The consistent presence of Harlequin Duck pairs at the end of May strongly suggests that breeding occurs in the claim block vicinity. Other sightings outside the claim block occurred on the Goodpaster upstream of Indian Creek, between West and Central creeks, and near the junction with the South Fork (Burgess and Ritchie, 2000).

Olive-Sided Flycatcher

The Olive-sided Flycatcher is similarly a species of concern, formerly listed as a Category 2 candidate species. Little is known of its population status in Alaska, but evidence suggests declining numbers across its range, similar to declines for several other neotropical migrant songbirds. Resource management agencies encourage research and management practices that may protect the species.

This species is present in interior Alaska only during late spring and summer months. Open black spruce woodland comprises the preferred breeding habitat for this species in the Pogo project area. During four annual surveys near the mine site from 1997 through 2000, five territorial males were recorded at four locations. Two of these locations were west of the Goodpaster River; one was south of the existing 1525 Mine Portal on the south side of Pogo Creek; and the fourth was in Liese Creek Valley, south of the creek on the north side of Pogo Ridge, in the vicinity of the proposed entrance to the 1875 Portal (Burgess and Ritchie, 2000).

Lynx

The lynx is a species of concern that has been proposed for listing as threatened in the Lower 48 states because of shrinking range and decreasing abundance. The species has been listed on Appendix II of CITES since 1977, and ADFG closely manages trapping harvests during periods of low abundance (e.g., during snowshoe hare declines). Populations in Alaska are considered healthy, but management agencies encourage monitoring and research to prevent future problems (Burgess and Ritchie, 2000).

Lynx occur throughout most of the boreal forests of Alaska (Tumlison, 1987), including mixed spruce–hardwood forests, open spruce muskegs, and aspen–spruce woodlands, but they use shrub habitats as well (Berrie, 1973; Stephenson, 1986). All of these habitat types are present in the project area, and lynx have been sighted there where suitable habitats and prey species occur. Currently, snowshoe hares are relatively abundant in interior Alaska, and lynx numbers have been rising in the last several years, judging from the increasing proportion of young animals taken by trappers (Taylor 1993, 1994, 1995; James 1996).

Rare Plants

Five rare plants are also species of concern due to rarity in their present-day ranges, including Alaska. They, too, were formerly listed as Category 2 candidate species, and surveys for their presence are encouraged to prevent significant impacts.

None of these five species was found in surveys of favorable habitat in the project area. *Aster yukonensis* typically is found on riverbanks, dry streambeds, and river deltas (Murray and Lipkin, 1987), but a search of riverine sand and gravel bars along the Goodpaster River in the vicinity of the claim block found none (Burgess and Ritchie, 2000). The other four species (*Cryptantha shackletteana, Draba murrayi, Eriogonum flavum* var*. aquilinum, and Podistera yukonensis*) generally are restricted to south-facing bluffs (characterized by remnant steppe vegetation) and low-elevation rubble slopes along interior rivers (Murray and Lipkin, 1987). These species have been found primarily along river bluffs (rubble slopes and steppe remnants) in the Tanana and upper Yukon River drainages. Although some suitable habitats (south-facing rubble slopes) are present in the project area, these sites are in upland areas away from the Goodpaster River, not in the typical river bluff habitats in which these rare plants have been found elsewhere (Burgess and Ritchie, 2000).

3.16 Socioeconomics

3.16.1 Socioeconomic Project Area

Most of the socioeconomic effects stemming from development and operation of the Pogo Mine project are expected to occur in the Delta Junction area which lies within the Southeast Fairbanks Census Area and in the Fairbanks North Star Borough (FNSB). The Southeast Fairbanks Census Area encompasses 25,934 sq mi, and straddles the Alaska Highway between the Alaska/Canada border and the FNSB. The census area's population of approximately 6,200 residents is sparsely distributed in 18 small communities that range in population from approximately 25 in Alcan to approximately 1,400 in Tok.

The Delta Junction vicinity is an unorganized area that includes the communities of Delta Junction, Big Delta, Fort Greely, and Healy Lake, as well as residents widely dispersed throughout the northwestern portion of the Southeast Fairbanks Census Area.

Delta Junction is located approximately 38 miles from the project site and could be linked to the mine by either an all-season road or a winter road. A portion of the mine's workforce could be drawn from Delta Junction and its surrounding population, depending on access to the mine. Also, nonresident miners might choose to reside in the community, again depending on how access to the mine is developed.

Employment and income effects in the Delta area could include the small and isolated Native village of Healy Lake. Healy Lake is located 31 miles from the proposed mine site. The village is accessible only by air, snowmachine in winter, boat in summer, and vehicle in the winter when an ice bridge is constructed across the Tanana River.

The FNSB boundary is only 7 miles from the Pogo Mine project site. A large component of the mine workforce could be drawn from Fairbanks, 85 miles northwest of the project site. In addition, Fairbanks would serve as the service and supply center for the mine. However, because the effects in Fairbanks of mine development on employment, income, and public services would be very small relative to the community's large economy and well-developed infrastructure, only general (rather than detailed) baseline data is provided for Fairbanks.

It is important to note that relatively little socioeconomic data is available for the Delta area specifically. Many economic and population data sources combine the Delta area with all other communities in the Southeast Fairbanks Census Area. In the following analysis, data is presented for Delta Junction (where available), the Delta area (including the communities of Big Delta, Delta Junction, Fort Greely, and Healy Lake), and the Southeast Fairbanks Census Area (in addition to the FNSB). Baseline data is included for Fort Greely, a military base that has been the economic backbone for the Delta area. Approximately one-quarter of the civilian and uniformed personnel stationed at Fort Greely live off the base (Alaska Department of Community and Economic Development [ADCED], 2000).

This socioeconomic analysis focuses on the communities in the Delta Junction area. Other communities in the Southeast Fairbanks Census Area, such as Tok (population 1,393, according to the 2000 Census), Northway (274), Tanacross (140), and Dot Lake (57), also play a role in the regional economy, although they would be unlikely to experience direct socioeconomic effects associated with development of the Pogo Mine. Northway, a predominately Alaska Native community situated 7 miles off the Alaska Highway and 165 miles from Delta Junction, is the most distant from the mine. Northway actually includes three settlements: Northway Junction, Northway (on the airport spur road), and the Native village (2 miles north of the airport).

Tok, located at the junction of the Alaska and Glenn highways, is about 100 miles southeast of Delta Junction. Considered the "Gateway to Alaska," Tok is the first major community upon entering Alaska on the Alaska Highway. Tanacross is a community with a population that is 90 percent Alaska Native. It is located just off the Alaska Highway on the south bank of the Tanana River, about 95 miles from Delta Junction. Dot Lake comprises two small communities, Dot Lake and Dot Lake Village, located on the Alaska Highway about 60 miles southeast of Delta Junction.

3.16.2 Delta Area

Population

Over the past decade the population of the Delta area declined from approximately 2,300 residents to approximately 1,700 residents in 2002 as a result of closure of Fort Greely (ADOL, 2000a).

Within the Delta area, however, some locales have experienced growth while others have declined. For example, Delta Junction, the community closest to the Pogo Mine project, experienced a 23 percent increase in population between 1991 and 2000, from 681 to 840 residents during the 10-year period (ADOL). Meanwhile, Fort Greely's population dropped by 62 percent (the result of a military base phase-out). Table 3.16-1 presents Delta area population estimates from 1991 to 2000. The increase in population in Big Delta in 2000 is likely the result of methodological changes in reporting rather than actual growth.

Table 3.16-1 Delta Area Population Estimates, 1991 – 2000

Locale	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Big Delta CDP	455	482	496	492	500	515	511	749	808	829
Delta Junction City	746	783	807	843	838	877	889	840	890	856
Fort Greely CDP	1,133	960	915	809	721	684	635	461	23	0
Healy Lake CDP	54	57	59	58	59	61	61	37	34	31
Delta Area Totals	2,388	2,282	2,277	2,202	2,118	2,137	2,096	2,087	1,755	1,716

Source: Alaska Department of Labor and Workforce Development, Research and Analysis, Demographics Unit, for 1993 through 1999 and 2001-2000 data.

CDP = Census Designated Place.

2000 data is from the U.S. Census Bureau.

The most recent data on the racial composition of Delta Junction and the Delta area population is from the 2000 census. Based on 2000 data, Big Delta and Delta Junction were predominantly White (89 percent or more); Fort Greely was approximately two-thirds White; and Healy Lake was 73 percent Alaska Native. Table 3.16-2 presents a breakdown by race and ethnicity of the Delta area.

Table 3.16-2 Population Distribution by Race and Ethnicity (Percent), Delta Area, 2000

	Race					Ethnicity
Locale	White	American Ind., Eskimo, Aleut	African American	Asian	Other	Hispanic Origin
Big Delta CDP	95.5	1.5	0.1	0.5	2.4	2.5
Delta Junction City	91.4	4.0	1.1	1.0	2.5	0.8
Fort Greely CDP	65.7	1.3	19.7	1.3	11.9	15.4
Healy Lake CDP	27.0	73.0	0.0	0.0	0.0	0.0
Delta Area Totals	86.1	3.7	4.8	0.9	4.5	4.6

Source: U.S. Bureau of the Census. Published by Alaska Department of Labor and Workforce Development, Research and Analysis, Demographics Unit.

CDP = Census Designated Place

Recent data on the racial and ethnic composition of the Southeast Fairbanks Census Area shows the Delta area (as defined above) accounts for approximately one-third of the population of the Southeast Fairbanks Census Area. This data indicates that the White component of the census area's population has not increased since 1990. During the same period, the African American component of the population dropped from 4.9 percent to 2.0 percent. As a percentage of total population, all other minority populations, except "all other," declined during the 1990-to-2000 period. This decline is an expected effect of military base closure. Russian speakers, including those mostly Russian or Ukrainian, account for 25 percent of the population in the Delta region (Korvola, 2000b). Table 3.16-3 presents the percent distribution and population, by race and ethnicity, of the Southeast Fairbanks Census area from 1990 to 2000.

According to ADOL data, the population of Healy Lake was 61 in 1999. However, others have estimated that about 40 people live in Healy Lake, with perhaps as few as 25 permanent residents (Korvola, 2000b). The community of Healy Lake was disbanded almost entirely in the mid-1940s, and the 1970 census reported no residents at all. In 1980 there were 33 residents, according to the census. All families involved in the re-establishment of Healy Lake are related to families documented to have resided there since at least 1910. At the time of the 2000 census, the population of Healy Lake was 37 people, including 10 family and 3 nonfamily households. Of the 37 people residing in the community, 27 classified themselves as Alaskan Native.

Table 3.16-3 Percent Distribution and Population Estimate, by Race and Ethnicity, in the Southeast Fairbanks Census Area, 1990 and 2000

	April 1, 1990		April 1, 2000		Change 1990 - 2000	
	Percent	Population	Percent	Population	Percent	Population
Race						
White	79.0	4,670	79.0	4,877	0.0	207
Native American	13.0	770	12.7	785	-0.3	15
African American	4.9	290	2.0	122	-2.9	-168
Asian/Pacific Islander	1.4	82	0.8	51	-0.6	-31
Other	1.7	101	5.5	339	3.8	238
Total	**100.0**	**5,913**	**100.0**	**6,174**	**0.0**	**261**
Ethnicity						
Hispanic Origin	3.0	177	2.9	167	0.0	-10

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Demographics Unit

Employment

Table 3.16-4 summarizes the latest available employment data for the Delta area. The table includes annual average employment for the Delta census subarea, which includes Big Delta, Delta Junction, Fort Greely, and Healy Lake, as well as the sparsely populated areas of Gerstle River, Donnelly, Delta Camp, Johnson River, and Shaw Creek. The table includes only nonagricultural wage and salary employment. It does not include uniformed military or self-employed workers.

The federal government was the largest single employer in 2001 in the Delta area, with 143 civilian personnel. Another 22 active duty military were stationed at Fort Greely in 2001 (ADOL). Including the federal government, the Delta Greely School District (DGSD), the State of Alaska, and the City of Delta Junction, government accounted for about 40 percent of the civilian employment in the Delta area.

Table 3.16-4 Delta Area Civilian Employment, 2001, Annual Average, by Employer

Business/Agency Name	Annual Average Employment
Federal Government	143
Delta Greely School District	93
State of Alaska	39
IGA Food Cache	38
Alyeska Pipeline Service Company	36
Schooley Group	25
Whitestone Farms, Inc.	20
Alaskan Steakhouse and Motel	16
Family Medical Center	15
Total All Others	373
Grand Total Employment	**720**

Source: Alaska Department of Labor and Workforce Development, Annual Alaska Population Overview

In 1990, Fort Greely's population was nearly twice that of Delta Junction. However, the 1995 Base Realignment and Closure Act called for closure of the army base. By 2001, Fort Greely's population totaled only 23 residents (the number of personnel stationed at Fort Greely actually began declining in 1992 after peaking at 489 active duty personnel). In addition to the loss of more than 450 active military personnel, the area has also lost 230 civilian jobs since employment peaked in 1993 at 948 jobs.

The loss of the area's largest employer (and about half of the region's economic base) has prompted local residents to look for other economic development opportunities. The Fort Greely Re-Use Plan includes, among other projects, use of the base as a NMDS site. Construction work is currently under way on a $325 million facility to test technology for destroying missiles in mid-course (ADOL, 2002). The facility is expected to be completed in 2004. Approximately 500 workers would be employed during the peak of the construction effort.

Other basic industries (those that draw new money into the Delta area) include state government, tourism, TAPS pipeline maintenance, mining, and agriculture. The DGSD is the second largest employer in the Delta area. In 2001, the district had 93 employees. School district employment has declined by about 30 percent since 1999. The DGSD is supported entirely by state and federal government funds. Other state government-related jobs in the Delta area include ADOT/PF positions.

Each year approximately 120,000 highway travelers pass through the Delta area, traveling to or from Fairbanks (McDowell Group, 2000). Many of these travelers pass through without spending much (if any) in the area; however, some spend money on fuel, food, lodging, and other miscellaneous services.

The Alyeska Pipeline Service Company is an important provider of high-paying, year-round jobs in the Delta area. As shown in Table 3.16-4, Alyeska's pipeline operations and maintenance activity in the area accounted for an annual average of 36 jobs. Annual payroll for these jobs likely totals between $1.5 million and $2 million.

Mineral exploration activity, coupled with the training opportunities made available through the Delta Mine Training Center (DMTC), has created mining industry employment opportunities for local residents. No data is available on the number of local residents employed in the mining industry. However, data from the training center indicates that 46 students have secured employment in the mining industry throughout Alaska.

Because agricultural employment is not reported by ADOL, there is no current data available on the role of agriculture in the local economy. It has been reported that in 1997 there were 71 farms covering 64,660 acres of land in the postal zip code area 99737. Farmers spent $2.98 million, and assuming that they at least broke even that year, the gross income from agriculture is estimated at about $3 million. In 1997 there were 5,900 acres in barley, 1,200 acres in oats, and 8,000 acres in hay and silage, and 1,400 cattle, 40 sheep, and an undisclosed number of hogs were raised. The four commercial greenhouses in the zip code area produced approximately $100,000 of income from plant sales. According to Korvola (2000b), agricultural activities in the Delta area have been severely hampered by adverse weather conditions in recent years. Anecdotal information suggests that farmers in the region generally supplement their incomes with other jobs in the community.

The Healy Lake economy is based on subsistence fishing and hunting in the summer and fall and trapping in the winter. Some residents work outside the village in Fairbanks, on the North Slope, or on the Pogo Mine project and seasonally at Harding Lake. At least two individuals have full-time employment with the local tribal government. During the last 5 years, there have been some federally funded building and infrastructure improvements at Healy Lake. Local hire at Davis-Bacon wages has been an important component of these projects (Korvola, 2000b). As in most villages in Alaska, public assistance provides an important source of cash for village residents.

Unemployment

According to the 2000 census in Delta Junction, 6.8 percent of potential workers were unemployed and 40.9 percent were not in the labor force in 2000. It is important to note that the Bureau of the Census and ADOL do not define unemployment in the same way. Census data reflects employment status at a specific point in time (in 2000) while ADOL data reflects an annual average, based on unemployment insurance claims. Table 3.16-5 presents unemployment rates for the Delta area in 2000.

Table 3.16-5 Unemployment Rates, Delta Area, 2000

Locale	Percent Unemployed	Percent of Adults Not in Labor Force
Big Delta	12.8	48.4
Delta Junction	6.8	40.9
Fort Greely	0.7	23.8
Healy Lake	11.6	34.9

Source: U.S. Bureau of the Census.

In 2001, unemployment in the Southeast Fairbanks Census Area averaged 10.7 percent, ranging from a high of 15.5 percent in January to a low of 8.0 percent in July. Annual employment rates for the Southeast Fairbanks Census Area are presented in Table 3.16-6. This data highlights the seasonal nature of the local economy.

Table 3.16-6 Unemployment Rates, Southeast Fairbanks Census Area, 1992 to 2001

Income	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Monthly Peak	19.0	17.8	18.6	18.4	20.5	20.3	14.5	14.8	16.5	15.5
Monthly Low	8.3	7.3	8.0	8.1	7.7	7.8	5.7	6.4	9.0	8.0
Annual Average	13.4	12.9	13.2	12.6	13.7	12.6	9.2	10.1	11.6	10.7

Source: Alaska Department of Labor and Workforce Development.

Income

The most recent income data available for the Delta area specifically is from the 2000 census. In 1999, median household income in Delta Junction was $43,500, 19 percent below the Alaska average of $51,571. Median family income in Delta Junction was $58,250, about 1 percent below the statewide average of $59,036. Delta Junction per capita income was $19,171, the highest level in the Delta area, but below the Alaska statewide average of $22,660. In the Delta area, income levels were lowest in Fort Greely, where 10.4 percent of the residents lived below the federal poverty level. Table 3.16-7 presents Delta area household, family, and per capita income in 1999.

Table 3.16-7 Delta Area Household, Family, and Per Capita Income, 1999

Income Category	Delta Junction	Big Delta	Fort Greely	Healy Lake
Median Household Income	$43,500	$49,000	$33,750	$51,250
Median Family Income	$58,250	$53,125	$32,969	$53,750
Per Capita Income	$19,171	$14,803	$12,368	$18,128
Percent Below Poverty	19.4	30.0	10.4	9.1
Persons in Poverty	163	197	45	5

Source: U.S. Census Bureau.

Between 1996 and 2000, per capita income in the Southeast Fairbanks Census Area increased at an annual rate of 3.3 percent, slightly below the statewide average growth rate of 3.4 percent and well below the national average of 5.0 percent. Table 3.16-8 presents per capita income for the Southeast Fairbanks Census Area from 1996 to 2000.

Table 3.16-8 Southeast Fairbanks Census Area Per Capita Income, 1996 to 2000

Census Area	1996	1997	1998	1999	2000	Average Annual Change
S.E. Fairbanks Census Area	$19,676	$20,669	$20,724	$21,580	$22,376	3.3%
State of Alaska	$25,901	$26,898	$27,645	$27,994	$29,642	3.4%
United States	$24,270	$25,412	$26,893	$27,843	$29,469	5.0%

Source: U.S. Department of Commerce, Bureau of Economic Analysis (ADOL, 2000b)

Wage and salary employment and payroll data can serve as a good indicator of the earning opportunities available in an area. Wage and salary data is not available for the Delta area because of confidentiality restrictions; however, data for the Southeast Fairbanks Census Area is informative.

Table 3.16-9 provides average annual employment, total payroll, and average monthly wages by industry. This data further highlights the importance of government employment and payroll in the area. Monthly wages paid by federal, state, and local governments combined are 70 percent above the private-sector average for the census area.

Other analysts have noted the importance of supplemental income sources such as retirement incomes and public assistance payments. Public assistance payments paid to residents in zip code 99737 (which encompasses Delta Junction, Fort Greely, Dot Lake, and Paxson), totaled approximately $1.6 million in Fiscal Year (FY) 2000 (Korvola, 2000b). Korvola also notes that public assistance payments to the Russian-speaking immigrant population may be playing an increasingly important role in the area's economy. Table 3.16-10 presents the number of households and individuals receiving public assistance payments in zip code 99737 in FY 2000.

Table 3.16-9 Employment, Total Wages, and Annual Average Monthly Wage by Industry, Southeast Fairbanks Census Area, 2001

Industry	Average Annual Employment	Total Annual Wages ($)	Average Monthly Wage ($)
Private Sector Totals	917	22,612,599	2,055
Mining	6	392,923	-
Construction	44	1,615,675	3,060
Manufacturing	19	343,355	1,506
Transportation, Communications, Utilities	225	10,507,160	3,892
Trade	343	5,372,436	1,305
FIRE	11	170,638	1,293
Services	266	4,210,412	1,319
Government Total	593	24,944,001	3,505
Federal	203	10,514,300	4,316
State	125	5,810,423	3,874
Local	265	8,619,278	2,710
All Industries Average/Total	1,510	47,556,600	2,625

Source: Alaska Department of Labor and Workforce Development.

Table 3.16-10 Public Assistance Payments to Residents in zip code 99737 in FY 2000

Program	# of Households	# of Individuals	Amount
Temporary Assistance Program	79	381	$795,159
Food Stamps	437	437	$433,878
Adult Assistance	89	89	$339,573
Medicare/Medicaid	435	852	NA

Source: Korvola (2000b), from Alaska Department of Health and Social Services.
NA = Not applicable because paid directly to health provider who might not be in the same zip code area.

Local Government Organization, Powers, and Finance

The City of Delta Junction was incorporated as a second-class city in 1960. It is governed by a seven-member city council. The city operates under a strong mayoral form of government. The city administers grants from the State of Alaska and federal sources, including state revenue sharing funds, roads and highway funds, grants from the Office of Economic Adjustment, U.S. Department of Defense, and ADCED (Hegarty, 2000). As a second class city, Delta Junction may, by referendum, levy property taxes. However, the city does not currently levy a property tax. It also does not levy a sales tax. The city's FY 2001 budget totaled approximately $400,000. Table 3.16-11 presents the City of Delta Junction budgets for the years 1998 to 2001.

The City of Delta Junction provides road maintenance services, which are limited to snow plowing on main roads in the city in winter. The city maintains and staffs part-time a community center and a library, which are in the same building as the City Hall. Households have individual wells and septic systems. Refuse is collected by a private firm, Delta Sanitation, and is deposited in the city-owned permitted landfill. Electricity is provided by GVEA, and residents and businesses generally heat with fuel oil (Korvola, 2000b).

Other local governing organizations in the Delta area include the Deltana Community Corporation and the Delta Greely Community Coalition. The Deltana Community Corporation is a nonprofit organization that acts as the fiscal agent for funding improvements outside the City of Delta Junction. The corporation's purpose is to encourage infrastructure and economic development, as well as coordinate emergency planning (Hegarty, 2000).

The Delta Greely Community Coalition was formed in 1995 to coordinate recovery efforts related to the closure of Fort Greely. The coalition has a 13-member board of directors and a professional staff of three. The board includes representatives of the Delta City Council, Deltana Community Corporation, Delta Chamber of Commerce, Delta Chapter of the Farm Bureau, DGSD, retired military and civil service employees, and active civil service employees (Hegarty, 2000).

The village of Healy Lake is an unincorporated community that is governed by the federally recognized Healy Lake Tribal Council. Residents are shareholders in the for-profit Doyon Regional Corporation and the Mendas Cha-ag Native Corporation, that are the Alaska Natives Claims Settlement Act (ANCSA) regional and village corporations for the area, respectively. The nonprofit Tanana Chiefs Conference (TCC), based in Fairbanks, provides a range of health care, social, and economic services to the residents of Healy Lake.

Table 3.16-11 City of Delta Junction Budgets, FY 1998 to FY 2001

Revenues	FY 98	FY 99	FY 00	FY 01
State Municipal Assistance	52,457	49,894	33,696	30,145
Transfer in from Permanent Fund	0	52,234	32,000	32,000
Transfer from General Fund	0	0	31,000	0
Revenue Sharing	28,310	28,105	25,923	25,027
Payment in Lieu of Taxes	0	230,264	220,000	235,434
Correction Facility	0	62,500	187,500	0
Fire and Ambulance Services	5,910	69,145	40,000	50,000
Community Center and Library	13,855	21,613	18,500	13,500
Electric & Telephone Coop Tax	5,512	4,850	4,800	5,200
Sanitary Landfill Revenue	4,700	4,800	4,700	4,700
Airport Tie-Downs	0	4,690	5,000	5,000
Other[1]	9,324	6,739	27,898	3,198
Miscellaneous Revenue	204,933	6,818	3,500	3,500
Total	325,001	541,652	634,517	407,704
Expenditures				
Administration	74,323	122,564	126,245	161,284
Correction Facility/FG Reuse	0	20,909	187,500	0
Community Center and Library	15,216	33,139	54,855	52,680
Fire Department & Rescue Squad	17,787	36,709	51,127	42,966
Sanitary Landfill	1,654	1,173	2,910	NA
Street, Facility/Runway Maintenance	20,881	28,371	21,691	33,749
911 Activity	11,281	45,743	88,415	NA
Other	2,488	22,931	29,574	8,882
Total	**143,630**	**311,539**	**562,317**	**399,111**

Source: The City of Delta Junction

[1] Includes revenues from and expenditures for hockey, land sales, the park, cemetery, games & amusement, and alcohol tax sharing.

Health Care and Public Safety

The Delta area's nearest public hospital is in Fairbanks. Providers listed below offer limited heath care services locally, some on a "visiting clinic" basis:

- Delta Junction Family Medical Center
- Crossroads Family Dentistry
- Delta Public Health Office
- Fairbanks Community Mental Health
- Deaf Community Services
- Alaska Department of Health and Social Services

Police, rescue, and fire-suppression services are provided by the following organizations.

- Alaska State Troopers
- Delta Rescue Squad
- Rural Deltana Fire Protection District

In the village of Healy lake, a clinic was built with federal funding through the TCC and completed in February 1998. The clinic has a full-time health aide through the TCC Health Aide program and Indian Health Service (Korvola, 2000b).

Education

Educational institutions active in the Delta area include the DGSD and DMTC. Whitestone Farms also operates a private school with a total enrollment of approximately 65 students (Korvola, 2000b).

The DGSD provides kindergarten through grade 12 public education. In FY 2001, the district's enrollment totaled approximately 630 students. Another 129 students are enrolled in the Delta/Greely Charter Cyber School, which was started in FY 1999 and whose students cyber commute from across the state. The DGSD operating budget has been declining in recent years in response to declining enrollment and is now approximately $5.3 million annually. Until 2001, local school facilities had included Delta Greely Elementary (grades pre-K through 6), Delta Junction High School (8-12), Fort Greely Elementary (PK-6), Fort Greely Junior High (7-8) and Healy Lake School (K-9). Because of declining enrollment, however, the schools at Fort Greely and Healy Lake have been closed (Korvola, 2000b).

Table 3.16-12 presents the DGSD enrollment from 1995 to 2001. Table 3.16-13 presents the DGSD operating budgets from 1995 to 2001.

Table 3.16-12 Delta Greely School District Enrollment, FY1995 to FY2001

Fiscal Year	K-6	7-12	Healy Lake K-9	Total	
95	523	441	10	974	
96	480	393	12	885	
97	443	391	8	842	
98	445	519	NA	964	
99	490	609	NA	1099	(771 + 324[1])
00	371[2]	391[2]	11	762	(593[2] + 169[2])
01	365	435	0	800	(629 + 171[1])

Source: DGSD. Taken from Korvola (2000b).

[1] Nonresident students enrolled in Charter Cyber School
[2] Includes students at Healy Lake
NA = not available

Table 3.16-13 Delta Greely School District Operating Budgets, FY 1995 to FY 2001

Fiscal Year	Operating Budget ($)
1995	7,076,270
1996	6,856,555
1997	5,656,878
1998	6,313,944
1999	6,993,877
2000	6,186,531
2001	5,295,618

Source: DGSD. Taken from Korvola (2000b).

Table 3.16-14 shows DGSD enrollments in bilingual, English proficiency, and Indian Education programs in FY 2001. As shown in the table, the DGSD has a high proportion of students coming from homes in which English is not the primary language. Apparently, most of the students enrolled in these programs are from Russian-speaking homes. Other non-English speaking students come from homes where Korean, Spanish, or German are spoken. Indian Education students may be American Indian or Alaska Native children. (This data does not include students who are enrolled in correspondence courses that are from sources other than the DGSD.) The data supports the community perception that the Russian-speaking population constitutes about one-quarter of the area's total population (Korvola, 2000b).

Table 3.16-14 Delta Greely School District Enrollments in Bilingual, English Proficiency, and Indian Education Programs, FY 2001

Grade	Bilingual	Limited English Proficiency	Indian Education	Total Students[1]
Elementary	78	69	8	302
High School	56	33	11	268
Preschool	4	4	1	17
Correspondence	30	27	2	56
Grand Total	168	133	22	643

Source: DGSD. Taken from Korvola (2000b).

[1] Total student numbers differ from those of the DGSD Central Office; they are based on different dates in the new school year.

A new school was constructed in Healy Lake in 1999 with $1.5 million in federal funds. The school was built because the DGSD was no longer able to use the Tribal Hall. The new school opened in December 1999 and was used until the end of the school year in May 2000. Today the school is closed because enrollment fell below the State of Alaska's required minimum of 10 students. Some of the students are attending boarding schools outside of the community and three are enrolled in home schooling programs (Korvola, 2000b).

The DMTC is a nonprofit organization whose membership includes the Alaska Miners Association, University of Alaska, TCC, Alaska Cooperative Extension, and DGSD. It is funded exclusively by grants. The DMTC was established to stimulate local hire for mineral industry jobs. Programs include an Associate degree in Applied Mining Technology, MSHA Certification, Hazardous Work Operations and Emergency Response Certification, Dislocated Worker Education, School to Work, and English Language Development. The English Language program is an important avenue for non-English speaking people to participate in the mineral industry. An estimated 20 percent of the DMTC students are from the Russian-speaking segment of the Delta community (Korvola, 2000b). Korvola provided a summary of the DMTC activities during 1998 to 2000:

- 23 total classes for 363 students from 1998 to 2000
- 295 credit hours earned through the University of Alaska Fairbanks (UAF) as of July 1, 2000
- 46 students employed by companies working in Alaska (Dynatec, Equity Engineering, Major Alaska Drilling, Procon, and Teck Resources Inc.) as of September 20, 2000
- $32,432 local purchases as of July 1, 2000
- $65,119 interior purchases as of July 1, 2000
- $200,738 total payroll as of July 1, 2000
- 12 local residents hired as of July 1, 2000

Housing

Because Delta is an unorganized, unincorporated area, very little recent detailed data on the housing inventory exists for the area. According to census data, the Delta area included approximately 1,888 housing units in 1990, including 688 unoccupied units. It should be noted that census housing data makes no distinction between primary residences and recreational or subsistence activity-related housing. Presumably, most of these unoccupied units are secondary residences that are not available units. Since 1990, the housing inventory in the Delta area may have increased by 100 units in response to population growth. Most recently, housing vacancy rates are probably increasing as a result of closure of Fort Greely.

Table 3.16-15 presents Delta area housing by occupancy status, and Table 3.16-16 presents Delta area housing by type. Data from the 2000 census is not yet available in the same level of detail as for the 1990 census. The housing inventory for Big Delta, Delta Junction City, Fort Greely, and Healy Lake combined totaled 1,029 units, including 616 occupied units, in 2000. However, this total excludes a large number of housing in outlying areas. Among the 413 unoccupied housing units in the area, more than half were at Fort Greely.

Table 3.16-15 Delta Area Housing by Occupancy Status, 1990

Occupancy Status	Delta Area	Tract 9559	Tract 9560[1]
Total Housing Units	1,888	1,508	380
Occupied	1,200	859	341
Owner	642	638	4
Renter	558	221	337
Vacant	688	649	39

Source: 1990 Census. Tract 9559 includes Healy Lake, Big Delta, and Delta Junction.
[1] Tract 9560 includes Fort Greely.

Table 3.16-16 Delta Area Housing by Housing Type, 1990

Units per Structure	Delta Area	Tract 9559	Tract 9560[1]
1, Detached	1,029	999	30
1, Attached	99	21	78
2	24	24	0
3-4	82	72	10
5-9	286	28	258
10-19	60	58	2
20 or More	0	0	0
Mobile Home	224	222	2
Other	87	87	0

Source: 1990 Census. Tract 9559 includes Healy Lake, Bug Delta, and Delta Junction.
[1] Tract 9560 includes Fort Greely.

The housing situation has changed since construction of the NMDS facility began; however, no data is available. Anecdotal evidence indicates that the NMDS construction program has consumed most of the available housing in the area. Part of the issue is that military housing is generally not available to civilian workers (although apparently some civilian construction workers are living on base temporarily). Therefore, although there is vacant housing in the Delta area, it is military and therefore not available to the general public.

Residential sales data provides an indication of the value, and perhaps quality, of homes on the market in the Delta area in recent years. Through the first 9 months of 2000, ten homes had sold in the Delta area, with an average sales value of $72,300 (Korvola, 2000b). Table 3.16-17 presents the average residential sales prices in the Delta area from 1991 until mid-2000.

In Healy Lake, according to the 2000 census, there was a total of 21 housing units in 2000. Thirteen of those units were permanently occupied; seven of these were owner-occupied, and six were renter-occupied.

Table 3.16-17 Average Residential Sales Prices in the Delta Area, 1991 to Mid-2000

Year	Average Price ($)	Number of Sales
1991	45,403	24
1992	41,728	17
1993	73,668	29
1994	79,595	39
1995	38,579	5
1996	50,628	9
1997	60,128	17
1998	59,750	17
1999	67,083	16
Through 9/00	72,300	10

Source: Mt. Hayes Inc., Realtors. Taken from Korvola (2000b).

3.16.3 Fairbanks North Star Borough

Population

The FNSB would serve as the service and supply center for the Pogo Mine project. Fairbanks is interior Alaska's largest urban and commercial center. The borough might also be home to some portion of the mine labor force. Fairbanks is located approximately 85 miles northwest of Delta via the Richardson Highway.

The population of the FNSB increased between 1992 and 1994, rising from 82,506 to 83,512, a 1.2 percent increase. After dropping to 81,941 in 1995, the population climbed back to 84,791 in 2002. Table 3.16-18 presents population counts and estimates for the City of Fairbanks and the FNSB from 1992 to 2001.

Table 3.16-18 Population Counts and Estimates, City of Fairbanks and FNSB, 1992 to 2001

Year	Fairbanks	FNSB
1992	32,959	82,506
1993	33,335	82,979
1994	33,249	83,512
1995	32,702	81,941
1996	32,960	82,880
1997	31,850	82,483
1998	31,601	83,299
2000	30,224	82,840
2001	26,558	83,530
2002	29,670	84,791

Source: U.S. Department of Commerce, Bureau of the Census, and ADOL. U.S. Census Bureau estimates are for April 1, and ADOL estimates are for July 1.

Approximately 82 percent of the FNSB population is White, 7 percent is Native American, 7 percent is African American, 2.6 percent is Asian and Pacific Islander, and 1.4 percent is of other race. The racial composition of the FNSB has not changed substantially during the past decade. Table 3.16-19 presents the percent distribution and population estimate, by race and ethnicity, for the FNSB in 1990 and 2000.

Table 3.16-19 Percent Distribution and Population Estimate, by Race and Ethnicity, FNSB, 1990 and 2000

		April 1, 1990		April 1, 2000		Change 1990 - 2000	
Race or Ethnicity		Percent	Population	Percent	Population	Percent	Population
Race	White	82.0	63,751	77.8	64,439	-4.2	688
	Native American	6.9	5,330	6.9	5,714	0.0	384
	African American	7.1	5,553	5.8	4,843	-1.3	-710
	Asian & Pacific Islander	2.6	1,998	2.4	1,965	-0.2	-33
	Other	1.4	1,088	7.1	5,879	5.7	4,791
	Total	100.0	77,720	100.0	82,840		5,120
Ethnicity	Hispanic	3.7	2,889	4.2	3,440	0.4	541

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section, Demographics Unit.

Employment

The FNSB economy is the second largest local economy in Alaska, with average annual employment of 34,303 and more than $1.1 billion in total annual payroll in 2001 . The Fairbanks economy has been growing steadily during the past 5 years, with employment increasing at an annual rate of 2.3 percent. Table 3.16-20 presents FNSB employment and payroll figures from 1997 to 2001.

Table 3.16-20 FNSB Employment and Payroll, 1997 to 2001

Category	1997	1998	1999	2000	2001
Average Annual Employment	31,376	32,336	32,538	33,475	34,303
Total Annual Payroll ($ millions)	952.7	993.4	1,017.4	1,087.1	1,146.5

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section.

The local economy is based on a large military presence (with 16,200 uniformed military and dependents), the University of Alaska (3,200 employees), tourism, and oil industry activity (Alyeska Pipeline Service Company is headquartered in Fairbanks). Other basic economic activities include mining (Fort Knox Mine employs 260 workers; plus most of interior Alaska mining exploration activity is staged out of Fairbanks), transportation services (Fairbanks is the supply center for interior and northern Alaska), regional health care, and state and federal government.

Unemployment

Unemployment rates in the FNSB averaged 5.7 percent in 2001. Unemployment rates typically increase during the winter months, and in January and February of 2001, unemployment stood at 7.6 percent, compared with the summer low of 4.5 percent. Table 3.16-21 presents FNSB unemployment rates from 1992 to 2001.

Table 3.16-21 FNSB Unemployment Rates, 1992 to 2001

Category	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Monthly Peak	13.0	10.4	10.8	9.7	9.7	10.9	7.6	8.2	8.1	7.6
Monthly Low	7.3	6.4	6.2	5.6	6.0	5.4	4.0	4.6	4.7	4.5
Annual Average	9.8	8.4	8.2	7.5	7.6	7.6	5.6	5.9	6.1	5.7

Source: Alaska Department of Labor and Workforce Development.

Income

Personal income for the FNSB totaled $2.3 billion in 2000, with per capita income averaging $28,260 (ADOL, 2000b). Table 3.16-22 presents FNSB personal and per capita incomes from 1996 to 2000.

Table 3.16-22 FNSB Personal and Per Capita Personal Income, 1996 to 2000

Category	1996	1997	1998	1999	2000
Personal Income (in $ millions)	1,949	2,049	2,135	$2,189	$2,338
Per Capita Personal Income (in $)	23,325	24,605	25,341	$26,245	$28,260

Source: ADOL, Research and Analysis Section.

Local Government Organization, Powers, and Finance

The 7,361 sq-mi FNSB is a second-class borough governed by a borough mayor and an 11-member assembly. The certified assessed valuation for purposes of local property taxes is approximately $4 billion. The FNSB includes two incorporated cities, the City of Fairbanks (population 31,000) and the City of North Pole, 12 miles southeast of Fairbanks (population of approximately 1,600 residents).

FNSB expenditures totaled $218.7 million in 1999, including $123.5 million for schools, $10.3 million on general government, $10.2 million on public works, $3.4 million on parks and recreation, $3.0 million on mass transit, $2.8 million on public safety, and $2.4 million on library/museum, plus additional expenditures on other services. FNSB 1999 revenues totaled $214.6 million, including $109.4 million in operating revenues from nonlocal sources (public school funding, shared revenue, other state revenue, and federal revenue), $74.3 million in operating revenues from local sources (property taxes, service charges, enterprise revenues and other local revenue), and $30.8 million in capital project revenue.

City of Fairbanks expenditures totaled $59.9 million in 1999, including $47.9 million on public utilities (electric, phone, water/sewer, and others), $8.7 million on police and fire services, and $2.3 million on general government, plus additional expenditures on other services. City of Fairbanks revenues totaled $67.9 million, including $62.3 million from local sources (property taxes, service charges, enterprise revenues, and other local revenue), $5.2 million from non-local sources (shared state revenue, other state revenue, and federal revenue) and $0.4 million in capital project revenue.

City of North Pole expenditures totaled $2.9 million in 1999, including $1.5 million on police and fire services, $0.6 million on public utilities (water/sewer and other public works), and $0.7 million on general government. City of North Pole revenues totaled $2.9 million, including $2.6 million from local sources (property taxes, service charges, enterprise revenues, and other local revenue) and $0.3 million from nonlocal sources.

Health Care and Public Safety

Fairbanks is interior Alaska's health care center. Denali Center Fairbanks Memorial Hospital is a 169-bed acute care facility that is owned by a nonprofit community foundation. It is co-located with the Denali Center, a 92-bed long-term care facility (Fairbanks Memorial Hospital, 2000). Approximately 1,900 professional health care providers and staff are employed in Fairbanks' health care sector.

Education

The FNSB School District operates 32 schools throughout the borough on an annual budget of approximately $107 million (Alaska Department of Education, 2000). Enrollment in 1999 totaled approximately 16,000 students.

Public education opportunities available in Fairbanks include UAF. UAF is a land, sea and space grant institution classified as a "doctoral II institution" by the Carnegie Foundation. Enrollment in the Fall of 1999 was 8,250 students. UAF is the borough's largest civilian employer with 3,200 full- and part-time employees (UAF, 2000). The FNSB also includes several private primary and secondary schools as well as trade schools.

Housing Inventory

The number of housing units in the Fairbanks area is very large compared to any potential demand due to mine development. With a population of approximately 84,000 residents, the FNSB has a housing stock of 30,000 units. Table 3.16-23 and 3.16-24 present rental vacancy data and rental rates, respectively, for the borough for 1999 and the first half of 2000. Table 3.16-25 provides housing sales data for the same period.

Table 3.16-23 Vacant Rental Housing Units, FNSB, 1999 to 2000

		Apartments				Houses				Mobile Homes	Cabins	Total Rentals
		Eff	1 BR	2 BR	3+ BR	1BR	2 BR	3 BR	4 BR			
1999	March	45	179	156	34	4	10	7	5	12	11	463
	June	13	73	135	43	4	13	16	4	11	14	326
	Sept.	51	133	187	57	8	16	23	7	19	22	523
	Dec.	55	201	153	52	11	18	9	3	8	21	531
2000	March	56	134	119	40	3	6	10	3	11	17	399
	June	32	69	92	37	6	8	16	3	12	22	297

Source: FNSB (2001)

Table 3.16-24 FNSB Average Monthly Rents for Available Housing Units, 1999 to 2000

		Apartments				Houses				Mobile Homes	Cabins
		Eff	1 BR	2 BR	3+ BR	1BR	2 BR	3 BR	4 BR		
1999	March	$409	$552	$697	$890	$627	$799	$973	$1,270	$632	$451
	June	442	547	706	959	712	967	1,005	1,343	691	343
	Sept.	479	545	714	921	593	834	1,246	1,292	634	442
	Dec.	461	541	699	921	684	856	1,148	1,306	650	391
2000	March	422	529	677	885	706	928	1,015	1,716	584	347
	June	422	540	719	889	758	668	1,139	1,400	687	380

Source: FNSB (2001)

Table 3.16-25 FNSB Residential Housing Sales Volume and Average Prices, 1998 to 2000

Yr/ Qtr	1 Bedroom Number Avg. Price	2 Bedroom Number Avg. Price	3 Bedroom Number Avg. Price	4 Bedroom Number Avg. Price	5+ Bedroom Number Avg. Price	Total Sold Number Avg. Price
1999						
1st Qtr.	5	28	47	16	8	104
	$54,300	$90,343	$132,853	$175,609	$169,238	$127,008
2nd Qtr.	12	54	101	40	7	214
	81,782	87,115	131,574	157,750	157,143	123,292
3rd Qtr.	12	57	111	46	7	233
	69,192	101,427	145,050	163,492	183,629	135,271
4th Qtr.	17	41	91	28	5	182
	66,841	88,319	137,139	171,791	156,260	125,431
Total	**46**	**180**	**350**	**130**	**27**	**733**
	69,989	**92,424**	**137,466**	**165,004**	**167,430**	**128,158**
2000						
1st Qtr.	14	30	76	32	132	165
	63,000	96,622	147,932	190,466	40,508	146,939
2nd Qtr.	11	49	116	41	10	227
	45,582	76,694	140,000	169,132	172,840	128,468

Source: Greater Fairbanks Board of Realtors and Alaska Multiple Listing Service, Inc. Taken from Korvola (2000b).

3.17 Land Use

Land status within the greater Pogo project area is shown in Figure 1.3-2. Ownership includes non-Native private parcels; private Native allotments; Doyon, Ltd. selected and conveyed private lands; Mental Health Trust lands; and Tanana Valley State Forest (TVSF) lands including TVSF research natural areas. Other land status includes the Goodpaster River Trail and Trail 53-Black Mountain (Teck-Pogo Inc., 2000d). In addition, as shown in Figure 3.17-1, there are approximately 10,000 mining claims in the area, covering approximately 387,000 acres. These claims include 1,281 covering 41,800 acres that are controlled by the Applicant (Hanneman, 2000). All of the Applicant's claims are on state-owned lands, including all proposed project facilities and alternative transportation and power transmission corridors (Teck-Pogo Inc., 2000a).

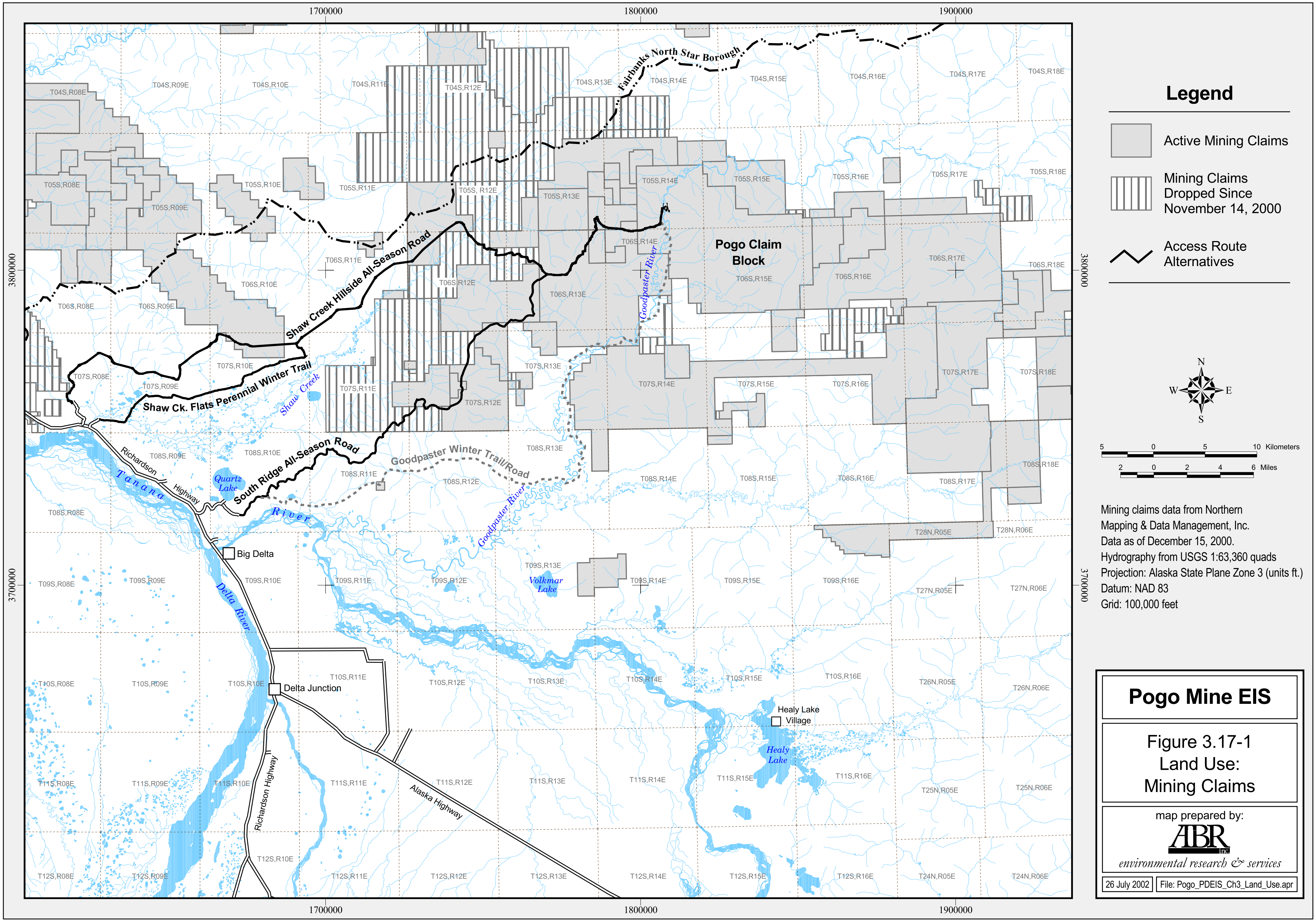
3.17.1 Land Management Plans

Land use in Alaska is regulated by federal and state agencies and local governments. In the vicinity of the Pogo project area, there are two State of Alaska land management plans and one local borough plan that affect land uses. The two state plans are the TBAP (ADNR,1991), and the TVSF Management Plan (ADNR, 2001b). Lands immediately to the west of the project area are subject to the FNSB Comprehensive Plan (FNSB, 1990).

- **Tanana Basin Area Plan** TBAP was adopted in 1985 and updated in 1991, and addresses state lands outside the TVSF. TBAP classified the land within the Pogo project area (Delta-Salcha Subregion) into four units: Shaw Creek, Quartz Lake, Tanana Uplands, and Goodpaster River (ADNR, 1991). Primary surface land uses within these four units include: public recreation, wildlife habitat, forestry, and minerals. The TBAP provides that state lands in these management units are to be retained in public ownership. Table 3.17-1 presents a land use designation summary for the four TBAP project area management units. Figure 3.17-2 shows the boundaries of those management units.

  TBAP recognizes that a variety of resources on state lands in the project area will require access prior to development or extraction of the resource. The plan specifies forest areas, recreation lands, and mineralized terrain areas as examples of such resources. State lands in the project area also are subject to the Areawide Land Management Guidelines for Subsurface Resources in TBAP, which include goals for the management of mineral resources in the planning area. These goals include contributing to Alaska's economy by making subsurface resources available for development, protecting integrity of the environment and affected cultures, and to aid in development of infrastructure, including roads, to support the mining industry.

  TBAP also recognizes the lower Goodpaster River Corridor for its recreational and scenic values. The plan specifies that any development activities in this area be designed to minimize the visual impacts to the lower Goodpaster River Corridor (where most private recreational cabins are located).



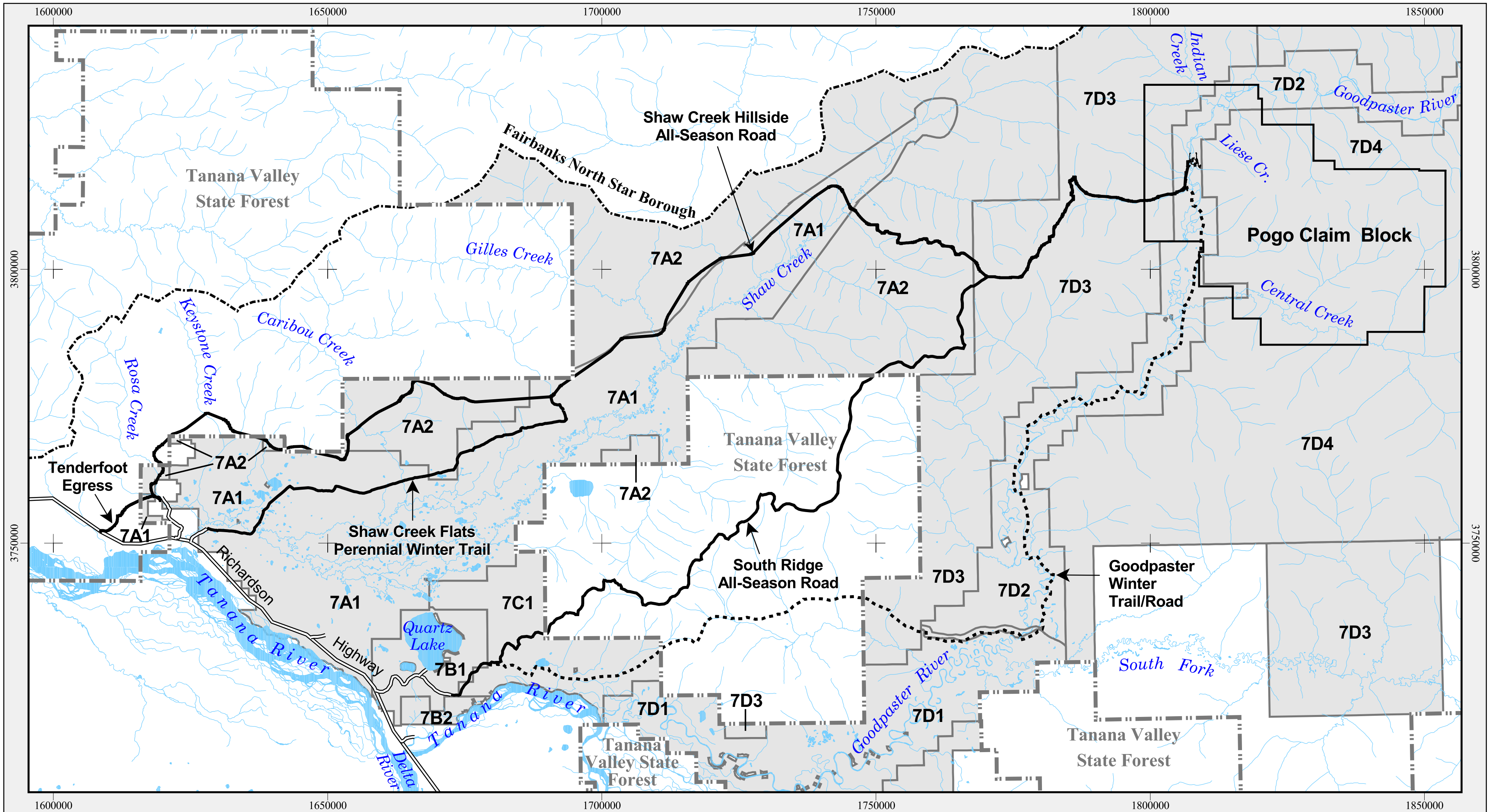
Pogo Mine EIS

Figure 3.17-1
Land Use:
Mining Claims

Table 3.17-1 TBAP Land Use Designation Summary for the Four Project Area Management Units.

Subunit	Primary Surface Uses	Secondary Surface Uses	Subsurface[1]	Prohibited Surface Uses[2]
Management Unit 7-A Shaw Creek Drainage				
Management Intent – Unit will be retained in public ownership and managed for its forest resources and protection of water quality, wildlife habitat, and public recreational values. This unit is open to mineral entry.				
7A1	Public recreation, wildlife habitat		Open	Land sales, remote cabins
7A2	Forestry, public recreation, wildlife habitat		Open	Land sales, remote cabins
Management Unit 7-B Quartz Lake				
Management Intent –Unit will be retained in public ownership and managed primarily for public recreation. Unit will remain open for mineral entry. Recreation opportunities should be enhanced; timber harvest activities should complement recreation activities.				
7B1	Public recreation	Wildlife habitat, forestry	Open	Land disposals
7B2	Forestry, public recreation	Wildlife habitat	Open	Land disposals
Management Unit 7-C Tanana Uplands				
Management Intent – Unit will be retained in public ownership for multiple use with an emphasis on public recreation and forestry values. Unit is open to mineral entry.				
7C1	Forestry, public recreation	Wildlife habitat	Open	Land disposals
Management Unit 7-D Goodpaster River Drainage				
Management Intent – Unit will be retained in public ownership and managed for multiple use, with an emphasis on recreation and fish and wildlife values. Unit will remain open to mineral entry. Lower Goodpaster corridor will be managed to maintain and enhance the river's recreational and scenic values. The upper Goodpaster corridor will be managed to maintain and enhance the habitat values of the river.				
7D1 Lower River	Public recreation, wildlife habitat		Open	Land disposals, all-season roads, timber harvest greater than 10 mbf, permanent commercial facilities
7D2 Upper River	Public recreation, wildlife habitat		Open	Land disposals, timber harvest within 100-year floodplain
7D3	Forestry, public recreation, wildlife habitat		Open	Land disposals
7D4	Public recreation, wildlife habitat		Open	Land disposals

[1] Locatable minerals. All areas are available for leasing for leasable minerals, except as noted for coal.
[2] Other uses such as material sales, land leases, or permits that are not specifically prohibited may be allowed if consistent with the management-intent statement.



Legend

7A1	Tanana Basin Area Plan Region 7 Project Area Management Subunit Boundary
	State Forest Boundary

5 0 5 10 Kilometers

2 0 2 4 6 Miles

N E S W

TBAP management unit boundaries from Alaska DNR Tanana Basin Area Plan, 1991
Base map: USGS 1:63,360 digital line graph mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 50,000 feet

Pogo Mine EIS

Figure 3.17-2 TBAP Project Area Management Unit Boundaries

map prepared by: ABR inc. environmental research & services

14 January 2003 | ABR File: Pogo_DEIS_Ch3_Land_Use2.apr

- **Tanana Valley State Forest Management Plan** The TVSF Management Plan was adopted in 1988, with a revision formally adopted in September 2001 (ADNR, 2001b). The TVSF Management Plan sets policy for how ADNR should review proposals for use of state land by the public, industry, and other governmental agencies. The management plan states that the primary purpose in establishment of state forests was "multiple use management that provides for the production, utilization, and replenishment of timber resources while perpetuating personal, commercial, and other beneficial uses of resources." It also clarifies that the state forest "shall be retained in state ownership."

  The management plan contemplates that where feasible and within the limits of available funding, full public rights of access should be provided when roads are constructed by state or local governments for purposes other than forest operations. Perpetual exclusive easements should be acquired and recorded when the state acquires access rights across property in other ownerships adjacent to the state forest.

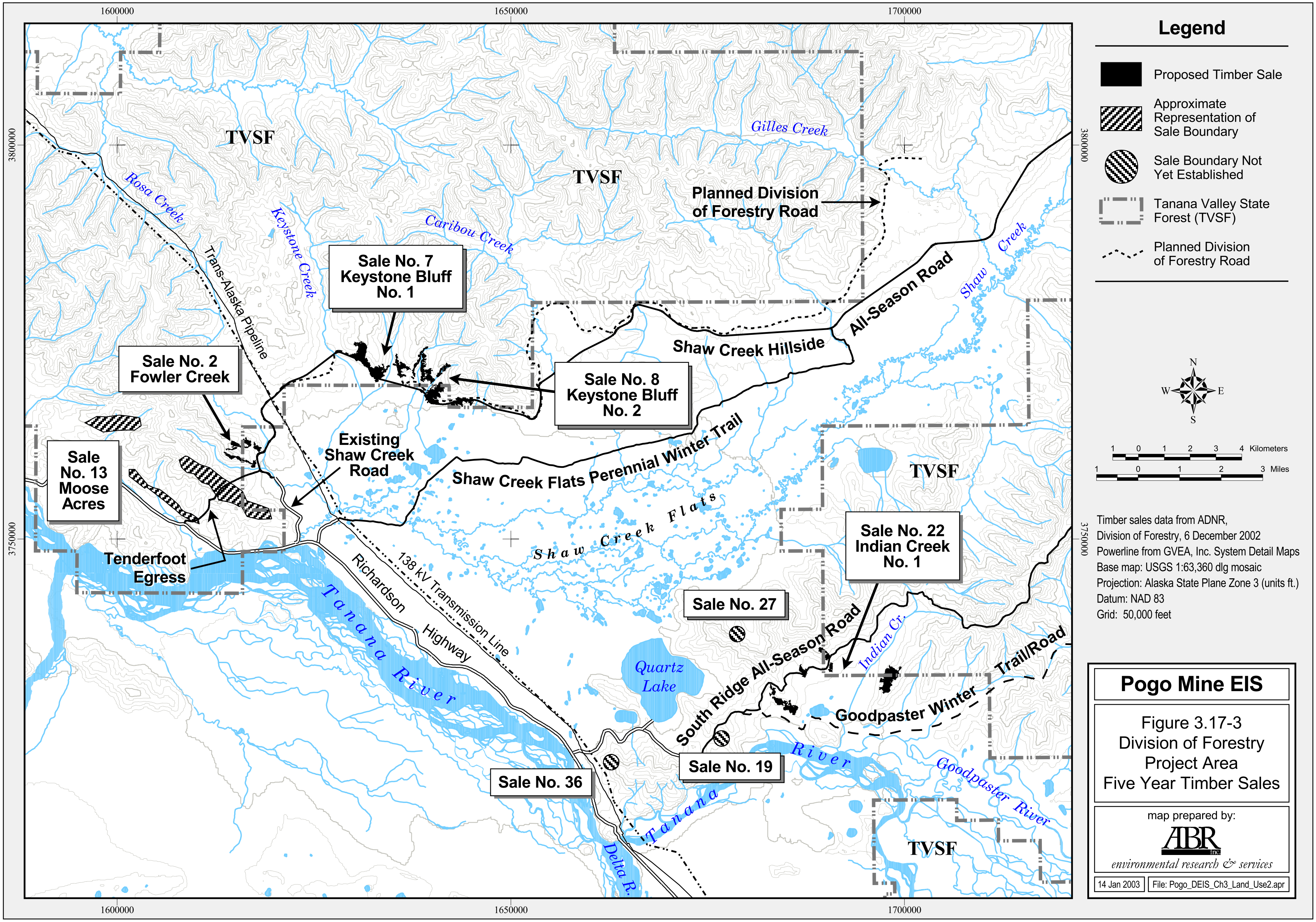
  The TVSF Management Plan designates lands within the Pogo project area for potential long-term timber sales, including areas within Rapid, Indian, and Progressive Creek drainages; and areas on the north side of Shaw Creek Flats, including Caribou Creek and Gilles Creek drainages. Areas on the south side of Shaw Creek Flats, and near Rosa Creek, have been designated natural research areas and closed to timber harvest. Timber has been harvested from the TVSF in the Pogo project vicinity during the last 15 years (Teck-Pogo Inc., 2000b).

  The management plan for the state forest in the project area recognizes the high mineral resource values in this unit, and states that it will be managed for commercial timber production and mineral exploration and production. These and other activities in these subunits will be managed to protect fish and wildlife values near the Tanana River and Shaw and Caribou creeks. The state has developed a portion of the winter trail on the north margin of Shaw Creek Flats to a primary winter road for timber access, and additional development of this winter access route will occur to access other timber sales. Primary all-season access is planned from the existing Shaw Creek Road to proposed timber harvest sales in the Keystone and Rosa Creek drainages.

  The DOF 5-year schedule for timber sales (2003–2007) in the Delta area includes four sales on the north side of the lower Shaw Creek drainage and the Tenderfoot area, and four sales in the Quartz Lake and Indian Creek area (ADNR, 2002). The locations of these proposed timber sales are shown in Figure 3.17-3. Table 3.17-2 presents a description of each sale, including acreage, volume, and an estimate of the number of round trip-truck trips necessary to harvest the timber. The eight sales during the 5-year period would total approximately 2,765,000 cubic feet of timber and affect approximately 1,313 acres.

  The Shaw Creek area sales at Fowler Creek and the two in the Keystone Bluff area are to be accessed by a new DOF all-season road in the Rosa Creek and Keystone Creek drainages. The Moose Acres sale in the Tenderfoot area would be accessed by new roads from the Richardson Highway.

  The four sales in the Quartz Lake / Indian Creek area would be south and east of Quartz Lake between the lake and the Tanana River (Quartz Lake #1 and Bert Mountain # 1), and northeast of Quartz Lake (Indian Creek # 1 and Shaw Creek # 6). The Indian Creek # 1 sale would be accessed by a new all-season road to and across Indian Creek, while the Shaw Creek No. 6 sale would be accessed by winter road in the Shaw Creek Flats.



Pogo Mine EIS

Figure 3.17-3
Division of Forestry
Project Area
Five Year Timber Sales

Table 3.17-2 Division of Forestry Project Area Five Year Timber Sale Schedule

Sale No.	Fiscal Year	Sale Name	Legal Description	Acres	Species	Volume in cubic feet	Access	Area Plan	Estimated Truck Round Trips (Entire Sale / Average Per Day)
2 NC-652	02 - 03	Fowler Creek	Sec. 21, W1/2 Sec 22, T7S, R8E	69	Spruce Sawlogs	100,000	All-season	TVSF 8A TBAP 7A2	142/2
7 NC-995	02 - 03	Keystone Bluff # 1	Sec. 4, 7, 8, 15, 16, 17, T7S, R9E.	134	Spruce Sawlogs	300,000	All-season	TVSF 8C TBAP 7A1	285/3
8 NC-1173	02 - 03	Keystone Bluff # 2	Sec. 4, 5, 6, 7, 8, 15 16, & 17,T7S, R9E.	230	Spruce Sawlogs	400,000	All-season	TVSF 8C TBAP 7A2	485/3
13	03 - 04	Moose Acres NC-673 NC-984	Tenderfoot Sec. 13, 23, 24, T7S, R7E Sec. 17-21, 27-30, 33 T7S, R8E	270 30	Birch/Aspen Spruce Saw	600,000 50,000	All-season	TVSF 8A	943/3
19	04 - 05	Quartz Lake # 1	Sec. 14-16, 21-23, 28-30, 32 T8S, R10E	70 150	Spruce Saw Birch/Aspen	120,000 160,000	All-season	TBAP 7B1 & 7C1	266/2
22	04 - 05	Indian Creek # 1	Sec. 13, 14, 22 & 23, T8S, R10E Sec. 18, 19, T8S, R11E.	200 50	Spruce Saw Birch	600,000 75,000	All-season	TBAP 7C1 TVSF 9A	950/3
27	05 - 06	Shaw Creek # 6	Sec. 2, 10, 11, & 15 T8S, R10E.	50 30	Spruce Saw Birch	150,000 40,000	Winter	TBAP 7C1 TVSF 9A	188/3
36	06 - 07	Bert Mnt. # 1	Sec. 25 & 36, T8E, R9E. Sec. 31 & 32, T8S,R10E. Sec. 4, 5, & 6, T9S, R10E.	60	Spruce Sawlogs	170,000	All-season	TBAP 7B1 & 7B2	162/2
Total				1,313		2,765,000			

Source: ADNR (2002) and Joslin (2002)

- **Fairbanks North Star Borough Comprehensive Plan** The FNSB Comprehensive Plan was adopted in 1984 and updated in 1990 (FNSB, 1990). The plan provides a framework for citizens and officials to make decisions related to the use of land and forms the basis for other land use ordinances and programs guiding land development and preservation. The borough also has a borough-wide zoning ordinance that was revised in 1988 (FNSB, 1988). The following land use designations from the FNSB Comprehensive Plan are applicable to parts of the greater Pogo project area: industrial, military, open space, reserve, and rural settlement land uses, including residential, agricultural, forest, and high mineral potential lands. While portions of the proposed project are near its boundary, neither the mine site area nor any of the surface access option routes are within the FNSB.

3.17.2 Federally Designated Military Lands

Federally designated military lands within the greater Pogo project area include Fort Greely, Eielson Air Force Base, and the Yukon 1 Military Operation Area. The Yukon 1 Military Operation Area, as designated by the FAA, is routinely used by the USAF to conduct military flight training exercises. Most routine military training missions originate from Eielson Air Force Base, located approximately 35 miles west of the Pogo project area.

Within the Yukon 1 Military Operation Area, the Air Force has established a military flight restriction zone in the Pogo area that is closed to all high-speed military aircraft. This restricted zone includes portions of Shaw Creek, the communities of Big Delta and Delta Junction, and additional areas on both sides of the Richardson Highway in the vicinity of Big Delta and Delta Junction (U.S. National Park Service [NPS] and ADFG, 1998).

In August 1999, to minimize risk of collision between military aircraft and civilian fixed-wing and helicopter aircraft flying in support of the Pogo project, the current flight restriction zone was enlarged to encompass a circular area with a 5-mile radius centered on Peak 4021, which is located 3 miles southeast of the Pogo deposit. This restricted area includes a corridor 4 miles wide centered on the Goodpaster River, extending from the Pogo airstrip to the southern edge of the Yukon 1 Military Operation Area, approximately 10 miles to the southwest. The restriction zone extends from the surface up to an altitude of 4,500 feet above mean sea level (Teck-Pogo Inc., 2000d).

3.17.3 Existing Land Use

The following existing types of land uses occur in the Pogo project area: commercial, industrial, military, recreational, residential; private parcels and cabins, transportation, and infrastructure (Teck-Pogo Inc., 2000d).

Commercial, Industrial, and Military

Commercial, industrial, and military activities in the project area include agriculture, timber harvest, backcountry expeditions, trapping, mineral exploration, and military installations and overflights (Figure 3.17-4).

Three agricultural tracts, totaling approximately 266 acres, are located near the end of the existing Shaw Creek Road; however, only two are active. One recently ceased its dairy operations but leases its hay fields. Two types of commercial backcountry expeditions operate in the project area: guided dog mushing tours in the Shaw Creek drainage and backcountry guided and nonguided hunting and fishing trips in the Goodpaster drainage that involve riverboat travel or a combination of aircraft and raft float trips. There are a number of trapping operators in the project area, covering all of the Shaw Creek, Salcha, and Goodpaster drainages (Ridder, 2002).

Figure 3.17-1 shows the mining claims in the project area. There are no currently producing placer or hardrock mines; however, several mining claim owners have conducted extensive mineral exploration on their properties (Figure 3.17-4). Other commercial and industrial activities in the project area include a year-round recreational lodge at Quartz Lake, a Quartz Lake boat livery, and two rock quarries: one along the Richardson Highway north of the Tanana River Bridge and the other adjacent to Shaw Creek Road. In addition, a military communications site is located west of the Pogo property and supports military exercises within the airspace designated Yukon 1 Military Operation Area (Ridder, 2002).

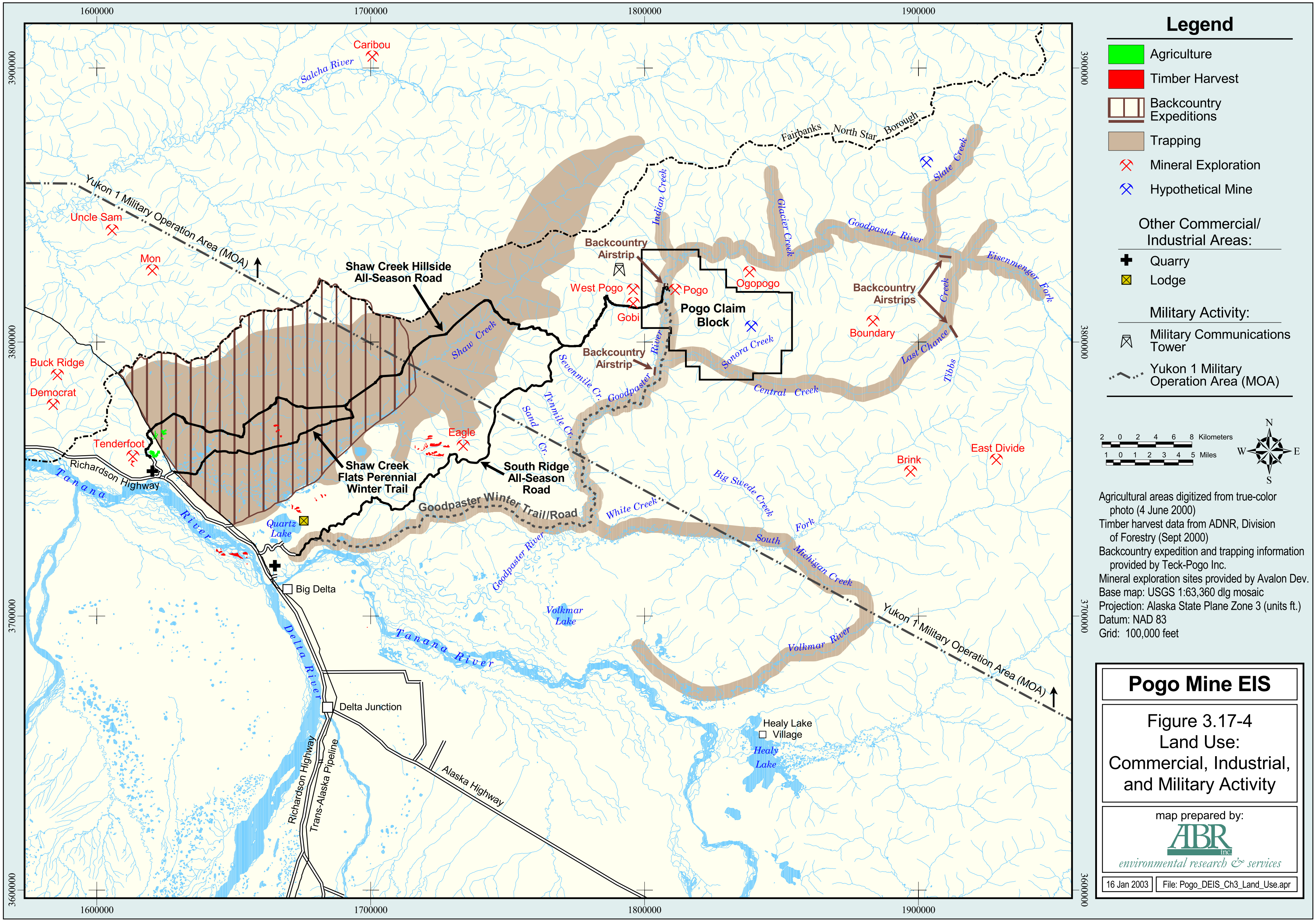
Residential, Recreational Cabins, and Other Private Parcels

Other land uses in the project area include residential, recreational cabins, and other private parcels (Figure 3.17-5). Within the Delta-Salcha subregion, 6,664 acres of state land were sold for residential use through 1989 (ADNR, 1991). In general, year-round residences are located near Shaw Creek, along the Richardson Highway near the Tanana River, along the Richardson Highway between the Tanana River crossing and Delta Junction, near the community of Delta Junction, and dispersed in a broad rural area among private land and agricultural parcels to the north and east of Delta Junction. There are six year-round residences on the existing, state-maintained, 2.1-mile-long Shaw Creek Road near Shaw Creek, four of which are presently occupied. Year-round residences consist of one north of Shaw Creek on the east side of the pipeline that uses the pipeline work pad for access and two residences within 2 miles northeast of Shaw Creek Road (Ridder, 2002).

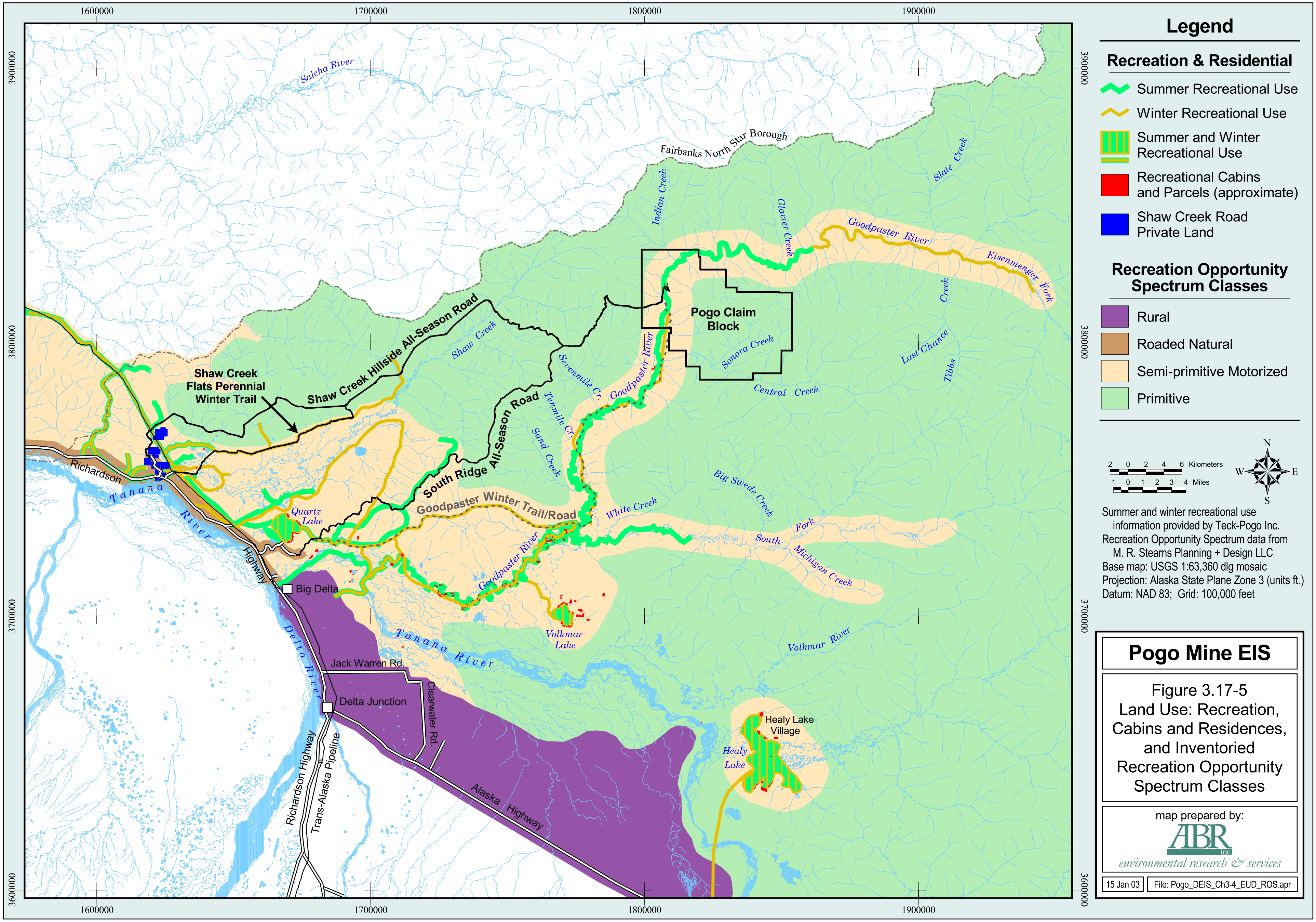
In general, recreational cabin sites and other private parcels in the project area are near river or lake access. Most of these cabin sites and other private parcels were acquired by individuals from the federal government prior to statehood in 1959 or from the State of Alaska during state-sponsored home site, open-to-entry, or other land disposal programs. There are approximately 63 Goodpaster River property households, 60 households at Quartz Lake and vicinity, and 10 Shaw Creek vicinity households, including the 6 accessed from Shaw Creek Road (Ridder, 2002).

Transportation and Infrastructure

Roads, trails, and infrastructure are shown in Figure 3.17-6. Both the state-maintained Richardson and Alaska highways border the greater Pogo project area. Two state-maintained spur roads are located near Shaw Creek and Quartz Lake, respectively, providing local access. Both roads were raised, received new culverts, and were chip sealed in 2001. Two gravel roads maintained by Alyeska Pipeline Service Company provide access from the Richardson Highway to the Trans-Alaska Pipeline. The pipeline traverses the project area for several miles, both underground and aboveground.

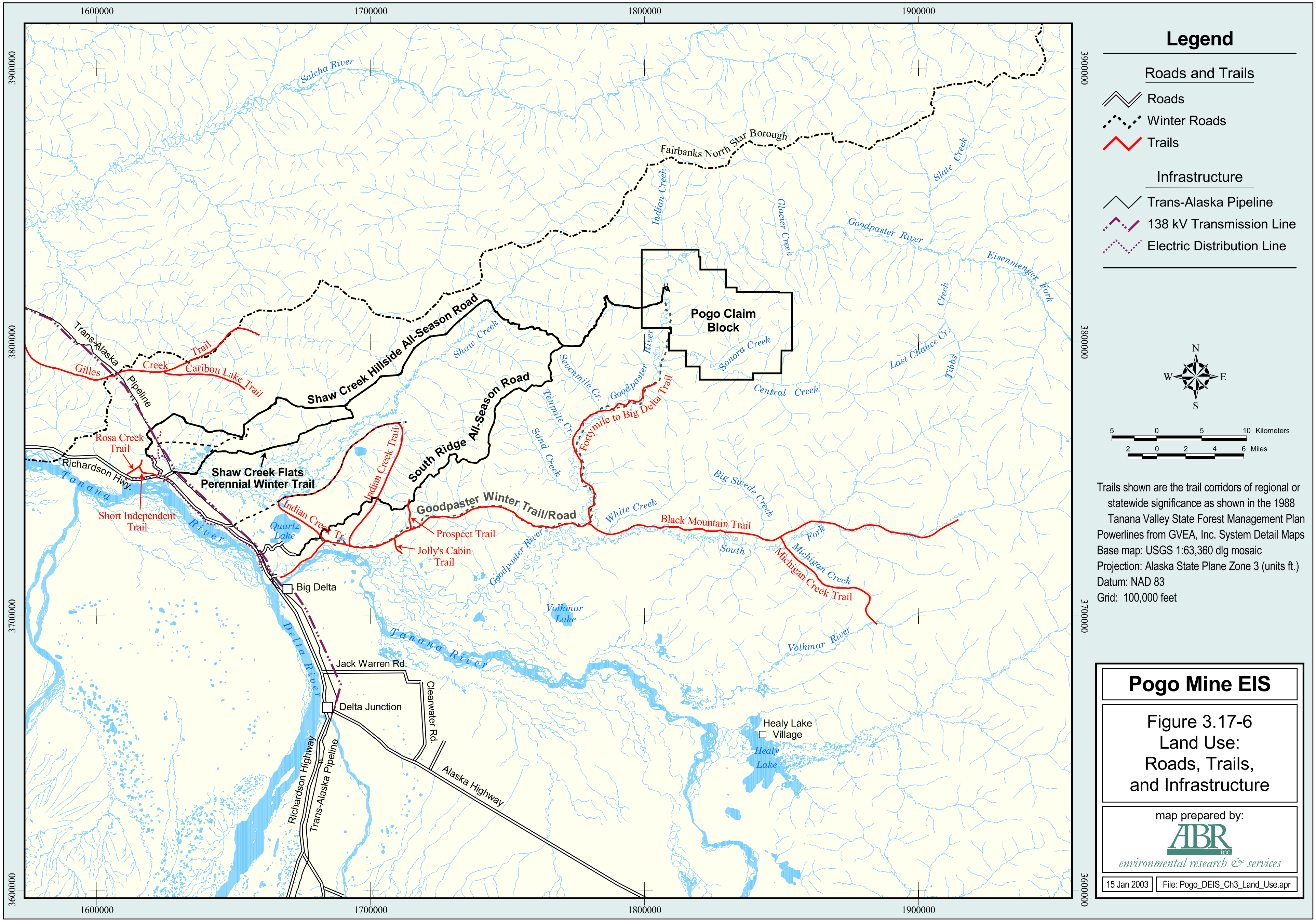


Legend
Agriculture
Timber Harvest
Backcountry Expeditions
Trapping
Mineral Exploration
Hypothetical Mine
Other Commercial/ Industrial Areas:
Quarry
Lodge
Military Activity:
Military Communications Tower
Yukon 1 Military Operation Area (MOA)
Kilometers
Miles
Agricultural areas digitized from true-color photo (4 June 2000)
Timber harvest data from ADNR, Division of Forestry (Sept 2000)
Backcountry expedition and trapping information provided by Teck-Pogo Inc.
Mineral exploration sites provided by Avalon Dev.
Base map: USGS 1:63,360 dlg mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 100,000 feet
Pogo Mine EIS
Figure 3.17-4
Land Use:
Commercial, Industrial, and Military Activity
map prepared by:
ABR inc.
environmental research & services
16 Jan 2003
File: Pogo_DEIS_Ch3_Land_Use.apr
Caribou
Salcha River
Uncle Sam
Mon
Buck Ridge
Democrat
Tenderfoot
Yukon 1 Military Operation Area (MOA)
Fairbanks North Star Borough
Shaw Creek Hillside All-Season Road
Shaw Creek
Shaw Creek Flats Perennial Winter Trail
South Ridge All-Season Road
Eagle
Goodpaster Winter Trail/Road
Backcountry Airstrip
West Pogo
Gobi
Pogo
Ogopogo
Pogo Claim Block
Indian Creek
Glacier Creek
Slate Creek
Goodpaster River
Eisenmenger Fork
Backcountry Airstrips
Boundary
Sonora Creek
Central Creek
Last Chance Creek
Tibbs
Sevenmile Cr.
Tenmile Cr.
Stand Cr.
White Creek
Big Swede Creek
South Fork
Michigan Creek
Brink
East Divide
Volkmar River
Volkmar Lake
Richardson Highway
Tanana River
Quartz Lake
Big Delta
Delta River
Delta Junction
Trans-Alaska Pipeline
Alaska Highway
Healy Lake Village
Healy Lake
1600000
1700000
1800000
1900000
3900000
3800000
3700000
3600000



Pogo Mine EIS

Figure 3.17-5
Land Use: Recreation, Cabins and Residences, and Inventoried Recreation Opportunity Spectrum Classes



Pogo Mine EIS

Figure 3.17-6
Land Use:
Roads, Trails,
and Infrastructure

The gated TAPS pipeline access road near Shaw Creek is for use only by local inholders, but it also provides unauthorized use for recreationalists and others with ATVs and snow machines who circumvent the gate for access along the pipeline pad across Shaw Creek Flats, as well as to the north as far as the Salcha River. A similar TAPS pipeline access road lies off the Richardson Highway west of Quartz Lake, but is not “controlled,” as is the Shaw Creek pipeline access road. This road provides public access to Shaw Creek Flats.

An unmaintained approximately 1-mile, dead-end primitive road constructed by the DOF branches off to the southeast from the Quartz Lake access road near the lake (Teck-Pogo Inc., 2000d). There are approximately 5 miles of existing DOF roads in the Tenderfoot egress area, including a 2-mile section with branching Caterpillar trails that end in deep bulldozed exploration trenches.

Another important transportation corridor in the project area is the Goodpaster Winter Trail, a historic public use trail now designated under RS-2477 as a public ROW. Portions of it were initially pioneered as part of the Washington-Alaska Military Cable and Telegraph System (WAMCATS). The Goodpaster Winter Trail has been used sporadically since the mid-1930s by many, including homesteaders, trappers, prospectors, hunters, dog mushers, skiers, other winter recreationists, and by landowners for access to their cabins along the Goodpaster River. In the winter of 1997-1998 it was used to supply Teck-Pogo Inc.’s advanced exploration work on the Pogo project (Teck-Pogo Inc., 2000d).

The TVSF Management Plan (ADNR, 2001b) discusses the many well-developed trails in the project area. Several of these trails systems are used by current residents and visitors for recreation and trapping activities. They include roads and trails through the Tenderfoot area, including a forestry road from the Richardson Highway and ATV trails beyond Rosa Creek.

There are four backcountry airstrips in the project area. One airstrip was constructed on a Goodpaster River gravel bar approximately 20 years ago at the Pogo project site. One was constructed in the 1930s at Tibbs Creek to support hardrock exploration. Another is a private strip constructed in the 1950s opposite Central Creek. The fourth is an enhanced gravel bar along the Goodpaster River used occasionally by high-performance bush aircraft (Teck-Pogo Inc., 2000d; Ridder, 2002).

A 138-kV, wooden, H-pole transmission line, operated by GVEA, parallels the Trans-Alaska Pipeline across the west side of the Pogo project area. The transmission line connects Delta Junction and Fort Greely to the Railbelt power grid. A local distribution line parallels the Richardson Highway and provides power along the highway and to Shaw Creek area residents.

3.18 Subsistence

3.18.1 Subsistence Definition

Because Native subsistence was identified as a scoping issue, the focus of the subsistence discussion in this EIS is on Upper Tanana Athabaskan subsistence uses. This focus is not meant to suggest that non-Natives are not subsistence users. Where non-Natives reside in the target Native communities, they also likely conduct seasonal harvest activities in the project area and may consider these activities subsistence uses. The ADFG subsistence use information referenced below includes community practices and not solely those of Native residents. Non-Native subsistence uses by residents of non-Native communities are included elsewhere in the EIS under sport hunting and fishing, and these non-Native users may individually consider themselves subsistence users.

Much of the material in this section was derived from a subsistence workshop conducted from August 21 through 23, 2001, in Tok, Dot Lake, and Fairbanks, with a follow-up contact on September 24 in Anchorage. The interviews with Upper Tanana Athabaskan subsistence users were coordinated by the Healy Lake Traditional Council (MENDAS CHA~AG Tribe) with a total of ten individuals. Results of this workshop are contained in SRB&A (2002a).

As defined by Alaska Statutes, "subsistence uses means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural 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 nonedible 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" (AS 16.05.940[32]). Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

The federal definition of subsistence comes from Alaska National Interest Lands Conservation Act (ANILCA), Title VIII, Section 803, and is virtually identical to the state definition: "The term '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 nonedible 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."

Although the term "rural" appears in both the state and federal definitions of subsistence, the Alaska Supreme Court has ruled that rural residents cannot be favored over nonrural residents.

The Alaska Federation of Natives (AFN) (2002) defines 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 world view, and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical."

The state definition of subsistence has been used in this analysis because the proposed project, and most of its effects, would occur on state land.

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 (ADFG, 1998b). Fishing and hunting for subsistence provide a reliable economic base for many rural regions (Wolfe and Walker, 1987), and these important activities are conducted by domestic family groups who have invested in fish wheels, gillnets, motorized skiffs, and snow machines. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production); it is focused toward 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, firefighting, or other services) provide the means to purchase the equipment 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 Athabaskans of interior Alaska (ADFG, 1998b). Subsistence fishing and hunting are important sources of employment and nutrition in almost all rural communities. ADFG (1998b) estimates the annual wild food harvest in interior Alaska is approximately 6,359,255 pounds, or 613 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.

To understand current subsistence use patterns in the Pogo project area, it is necessary to review the historical settlement patterns, the seasonal round of subsistence resource gathering, the traditional band areas in the region, and traditional subsistence patterns that transcended band territorial boundaries.

3.18.2 Historical Patterns of Subsistence Resource Use

Settlement Patterns and Seasonal Round

Traditional Athabaskan life was based on a mobile subsistence round of traveling from camp to camp at specific seasons to harvest resources generally available at certain times in known places (McKennan, 1959, 1969a, 1969b, 1981; Shinkwin *et al.,* 1980; Andrews, 1995; Simeone, 1982, 1995; VanStone, 1974; Cook, 1989; Mishler, 1986; and Stephen R. Braund & Associates [SRB&A], 2002a). Traditional Athabaskan culture in the Upper Tanana Valley was “based on a highly mobile annual subsistence cycle that included hunting, fishing, gathering and trapping (Shinkwin *et al*., 1980:46). Mobility ranged from very high mobility (occupation of numerous small camps during the year and rare concentration of band personnel) to low mobility (potential for occupying one major camp or village year-round) (Guedon, 1974).

Despite the seasonal mobility associated with following resource concentrations, some locations were often used for longer time periods than others. Shinkwin *et al*. (1980:43) described Upper Tanana Athabaskans as living in “semi-permanent settlements in the lowlands” that were “placed in locations that would minimize travel distance and time to other major resources.” According to Shinkwin *et al*. (1980), three resources in the area occur in dense concentrations seasonally – caribou, whitefish, and waterfowl. Seasonal resource availability dictated where the Tanana Athabaskans were at particular times of year and the number of seasons a particular site might be occupied. Thus, people would base out of a core settlement and move from traditional location to location at key seasons to harvest resources known to be in the vicinity at particular times of the year. As a result, seasonal occupation of the same or similar places occurred year after year (SRB&A, 2002a).

Traditionally, Athabaskan groups "were dispersed for most of the year, pursuing sheep, moose, caribou, waterfowl, fish, muskrat," and other resources "nucleating at a base camp along lakes and clear water streams in late spring and summer for migratory waterfowl and whitefish runs, and in the fall in strategic areas to obtain migrating caribou. Minor subsistence systems, such as muskrat trapping and berry collecting, overlapped the fish-fowl system and moose and sheep hunting overlapped the caribou subsistence system" (Shinkwin *et al*., 1980:46). The core settlement was often located near the winter camp or summer fishing camp, and this camp was centrally located relative to resources and auxiliary seasonal camps.

The traditional/historic seasonal round of subsistence activities in the Upper Tanana region is illustrated in various sources (e.g., McKennan, 1959, 1981; Guedon, 1974). These sources show that fishing was a summer activity (with limited winter involvement) and moose were sought throughout the year, with concentrated harvest efforts occurring mid-March through April (cows without calves) and mid-July through September (bulls). Caribou migrated through the region in early summer (April to June) and in the fall (late August through December). The fairly stable migration pattern allowed for the construction of semi-permanent caribou fences. Sheep were harvested in July though August/September. Trapping began in November and extended through late February or early March, and waterfowl hunting occurred in spring and fall. Gathering berries was primarily a summer and fall activity, whereas gathering firewood and other plants occurred, in varying levels of effort, throughout the year.

Traditional Band Areas

According to McKennan (1981), the Tanana Indians had no self-defined "tribal" identity, but they "thought of themselves in terms of small local bands that constituted both social and geographical units. Frequently several contiguous bands would be sufficiently interlocked through marriage, geography, and common interests for them to consider themselves a larger unit, or regional band, of which the Upper Tanana division is a good example. McKennan (1981:565) stated, "It is evident that except for natural boundaries such as high mountain ranges, it is extremely hard to draw precise territorial limits for these nomadic people. Adjacent local bands often came together for purposes of communal hunting, trade, or potlatch ceremonies except for those periods when local 'wars' temporarily separated them."

McKennan (1969:100-105, as cited in Shinkwin *et al*. 1980:46) described two types of bands present in the Upper Tanana Valley: local bands and regional bands. Local bands ranged (in interior Alaska) "from 20 to 75 persons, sharing an extensive territory over which they ranged in small groups, coming together in the summer for fishing and in the winter for collective hunting." Regional bands were composed of several contiguous local bands united by marriage and sharing a common territory. Shinkwin *et al*. (1980:46) stated that "social units were fluid and represented open social systems which could incorporate new members when necessary." He also said that the units were "well adapted to the ecological constraints represented by interior Alaska," and that social organization in the Upper Tanana area were "closely controlled by ecological considerations reflected in the land use patterns." Three bands are relevant to this discussion: (1) the Delta-Goodpaster Band, (2) the Healy River-Joseph Band, and (3) the Mansfield-Kechumstuk Band (SRB&A, 2002a). It is important to note that band areas, while delineating the territory or "property" of the band, do not necessarily represent the area in which each band travels, hunts, or harvests. That latter area is much larger than each band's individual "territory" (SRB&A, 2002a).

Traditional Caribou Hunting Camps

Bands in the Upper Tanana Valley used both lowland summer camp or settlement locations and a traditional caribou hunting camp in their seasonal rounds. For example, both the Healy River-Joseph Band and the Mansfield-Kechumstuk Band used lowland summer camp or settlement locations (Healy River and Mansfield) as well as caribou hunting camp locations (Joseph and Kechumstuk) situated upland at the base of or in the mountains (SRB&A, 2002a). The literature review did not reveal any discussion of caribou camp locations for the Delta-Goodpaster Band. However, several cultural resources associated with caribou hunting and caribou corrals for this band have been documented (SRB&A, 2002a; Harritt, 2001).

3.18.3 Traditional Subsistence Use Areas versus Band Territorial Boundaries

According to McKennan (1981), precise territorial limits for the nomadic peoples who participated in communal trade, hunting, and potlatch ceremonies among bands were difficult to determine. Several cultural practices (kinship, marriage patterns, matrilocal residence rules, fluidity between bands) and historical patterns (nucleation of communities) serve to show how travel, hunting, and harvesting occurred across these band territories. Furthermore, as whites moved into the area beginning in the early twentieth century, introducing disease, trade goods, missionaries, and policies, residence patterns shifted. These shifts also affected subsistence use patterns (SRB&A, 2002a).

Travel/Hunting/Harvest Area Larger than Traditional Band Area

Traditionally, travel, hunting and harvesting areas often occurred outside of the traditional band territories (SRB&A, 2002a). Multiband subsistence activities often occurred, such as communal cooperation in corralling caribou with fences, and band territorial boundaries became flexible in times of need or periods of resource fluctuation. It was not uncommon for one band to join another band if resources were more abundant in the neighboring or more distant band territory. The use of another band territory was generally with permission (SRB&A, 2002a). The reciprocity and temporary movements of a group during times of need were possible due to established kinship ties. Bands also attended joint ceremonial activities with neighboring bands, resulting in a strengthening of the network ties between bands.

Matrilocal Residence Rule

Upper Tanana Athabaskan bands followed a matrilocal residence rule; for the first few years after marriage, the couple lives with the wife’s parents or band, resulting in a husband becoming familiar with more than one hunting area (his band’s hunting area and his wife’s band’s hunting area). Intermarriage and moving from location to location among Upper Tanana bands were common (SRB&A, 2002a).

Kinship

Kinship was, and continues to be, important to Upper Tanana Athabaskans. Tanana Athabaskan society followed exogamous matrilineal descent rules (kinship traced through maternal line and people marry outside of their own band), which strengthened bonds between bands and offered a broader network of kinship ties. Members of one clan could seek help or hospitality from other clan members, regardless of where they lived. In addition, one could seek assistance from his formalized subsistence “partner.” The preferred marriage pattern was cross-cousin marriage in which a man or woman would marry the father's sister's children or the mother's brother's children (McKennan, 1981). In this arrangement, one's "partner" would be both a cross-cousin and brother-in-law. "Rights and duties were reciprocal between partners and included the specified division of any game taken by either" (McKennan, 1981). Intermarriages between Salcha, Delta-Goodpaster, Healy River-Joseph, and Mansfield-Kechumstuk bands were common, and over time, strong interrelationships developed in which people were welcome by kinsfolk over a large geographic area (SRB&A, 2002a). Visiting, providing assistance, attending ceremonial events, sharing hunting areas (respectively with permission), sharing subsistence foods, and trading were common practices among kin relatives in different bands. These activities continue today across the broad area where relatives live (SRB&A, 2002a).

Regional Band

According to McKennan (1981:562), "frequently several contiguous bands would be sufficiently interlocked through marriage, geography, and common interests for them to consider themselves a larger unit, or regional band, of which the Upper Tanana division is a good example." Thus, contiguous local bands, united by marriage and sharing a common territory, could be perceived as a "regional band." This classification in itself is not significant; what is significant is that the Athabaskans living in the region viewed themselves as having sufficient relationships and common interests to be a part of a larger group that included sharing of subsistence foods, hunting territories, visiting, and other social relations.

Nucleation of Communities

As trading posts, missions, schools, and other influences from whites entered the Upper Tanana Region, Athabaskans tended to move to centralized locations beginning what Shinkwin *et al*. (1980) described as a "nucleation involving year-round permanent settlements." This centralization or aggregation occurred gradually as people moved to Healy Lake (fur trading post), Tanacross (mission), and Tetlin (store), for example. Permanent year-round settlement by Athabaskans did not occur immediately because the traditional life-style could not be pursued in one location (Shinkwin *et al*., 1980:47), but over time, people lived more permanently in these year-round settlements, generally centralized around the trading posts, missions, or school.

The placement of these villages, similar to the placement of traditional fish camps, very often occurred in areas where three or more resources could readily be attained and, ideally, the availability of at least one concentrated resource (e.g., fish or caribou) that could be stored (Shinkwin *et al*., 1980). Often these settlements occurred near fish camps that were a part of the more mobile seasonal subsistence residence pattern. The "village" maintained separate camps for caribou, moose, sheep, fish, and waterfowl (Shinkwin *et al*., 1980). For example, Healy Lake, the current community in the territory of the Healy River-Joseph Band, was established at the mouth of the Healy River in 1907 when a fur trading post was constructed there (Cook, 1989). From this location, hunters branched out into the uplands and mountains (for caribou and sheep), along the waterways for fish, waterfowl, and moose, and, ideally, in the nearby vicinity for small game, berries, moose, fish, furbearers, and waterfowl.

This "centralization" or "nucleation" of what was once a more dispersed residence pattern into more semi-permanent communities resulted over time in a more sedentary lifestyle, although frequent mobility persisted (Andrews, 1995). Subsistence hunting and gathering trips occurred from the centralized community rather than moving residences seasonally. Community hunters and gatherers could travel to the various camps that they and their ancestors had traditionally used to harvest caribou, moose, sheep, waterfowl, and other available resources. With the exception of Healy Lake, which has been used for a long time based on archaeological findings, none of the settlements were traditional (pre-contact) camps, although most are in the vicinity of traditional camps (Shinkwin *et al*., 1980).

This establishment of more permanent villages in association with fur trading posts was described by McKennan (1981:567): “The development of the fur trade not only brought obvious changes in Tanana material culture but also affected profoundly the subsistence pattern, round of seasonal activities, social organization, and demography. Semi-permanent villages (Healy Lake, Tanana Crossing…) grew up in the neighborhood of the trading posts.” Several members of the Mansfield-Kechumstuk Band moved to Tanacross (SRB&A, 2002a). In addition, descendents and members of the Healy River-Joseph Band live in Fairbanks, Delta Junction, Healy Lake, Dot Lake, and Tanacross, and have relatives in Northway, Tetlin, and other communities (SRB&A, 2002a).

The change from the traditional, dispersed residence pattern in which band members moved seasonally to pursue subsistence resources to living in more centralized communities has had substantial effects on subsistence activities. Today, people do not nomadically follow resources as they did a hundred years ago. Instead they go on hunting, fishing, and gathering trips based out of the residence community and then return to that community. Furthermore, they often travel, among other locations, back to their traditional band areas. Thus, people with kinship and ancestral ties to traditional band areas who are now living in a host of communities located along the highway, including Fairbanks, Delta Junction, Dot Lake, and Tanacross, continue to return seasonally to their ancestral band areas in pursuit of specific resources known to be available in those areas at certain times of the year (SRB&A, 2002a).

3.18.4 Contemporary Subsistence Resource Use Patterns

Pogo Project Area

Upper Tanana River Athabaskan residents from Healy Lake, Dot Lake, Tanacross, Delta Junction, Northway, and Fairbanks use the Pogo Project area for subsistence purposes. Although Marcotte (1991) and NPS (1995) do not indicate any subsistence uses in the Pogo project area for residents of Tok and Tetlin, some may occur. Generally, those individuals who used this area had current and/or ancestral kinship relationships and/or band affiliations with the Delta-Goodpaster or Healy River-Joseph bands. The continued use of different areas by descendants of various bands is intentional and a means of ensuring clan obligation, reciprocity, and sharing of resources (SRB&A, 2002a).

Upper Tanana Region

Upper Tanana River Athabaskans use diverse subsistence resources found in the Tanana River Valley. These resources include, but are not limited to, terrestrial mammals such as caribou, moose, sheep, and bear, small, fur-bearing mammals such as beaver, muskrat, lynx, coyote, marten, hare, and red fox, waterfowl and upland birds, anadramous and resident fish, and berries and plants used for traditional and ceremonial purposes (SRB&A, 2002a).

Subsistence harvest and use of natural resources continues to play a vital role in the economy and culture of the Tanana Athabaskans (SRB&A, 2002a). Currently, the most important subsistence foods include moose, caribou, fish (whitefish, grayling, trout, and burbot), upland birds (grouse and ptarmigan), waterfowl (ducks and geese), porcupine, beaver, and berries.

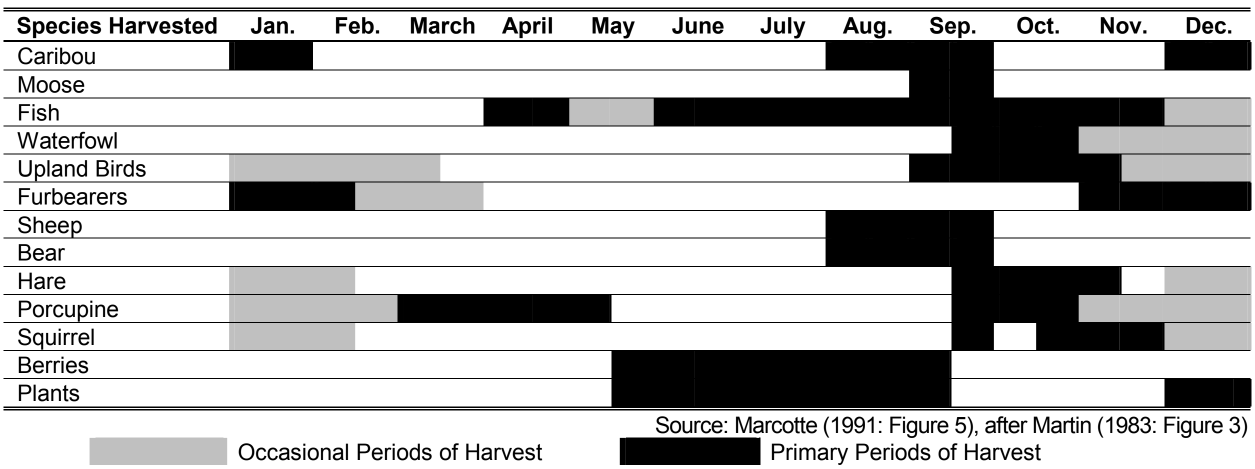
Subsistence hunting tends to be opportunistic in nature. That is, individuals often hunt for multiple resources during the course of a single hunting trip or hunt while traveling for a variety of purposes. For example, an individual might be hunting for moose, but would also harvest upland birds, waterfowl, and berries if presented with the opportunity (SRB&A, 2002).

Contemporary Seasonal Round

Contemporary use patterns differ from historical use patterns in several respects. Currently, subsistence harvest trips are based out of one's community of residence, as opposed to the traditional practice of moving residences seasonally. Also, contemporary use patterns exhibit longer periods of fishing and shorter periods of time hunting large mammals (primarily due to regulatory restrictions). Although there are legal seasons for harvesting resources, such as moose and caribou, other resources are collected throughout the year (e.g., fish) (SRB&A, 2002a).

Table 3.18-1 shows the seasonal subsistence round for Dot Lake in 1983. The activities generally correspond with information gathered in 2001 (SRB&A, 2002a), with the exception that Healy Lake fishing extended year-round. Other differences between the Healy Lake and Dot Lake seasonal round are that Dot Lake residents did not hunt for moose or waterfowl in the spring in 1983 and Dot Lake did not report hunting for moose, caribou, or upland birds in the summer. Both Dot Lake and Healy Lake seasonal rounds indicate a strong subsistence focus during the fall months.

Table 3.18-1 Contemporary Seasonal Round of Subsistence Activities, Dot Lake, 1983



Source: Marcotte (1991: Figure 5), after Martin (1983: Figure 3)

Subsistence Harvests

One general indicator of subsistence use in rural Alaska is the amount of subsistence harvest in communities. Available published information indicated that Healy Lake (Gerlach, 2000) and Dot Lake (NPS, 1995) harvested resources in the Pogo Project area. The ADFG Division of Subsistence (2001), which routinely compiles subsistence harvest data for rural Alaska communities, does not have any systematically gathered subsistence harvest data for Healy Lake. ADFG general harvest data for GMU 20D (within which the Pogo project is located) is available (Gerlach, 2000). However, this data is of limited use because it does not distinguish between general and subsistence harvest; it does not indicate the resident community of the harvesters, and it does not include all species.

Although systematically collected subsistence harvest data is not available for Healy Lake, it is available for the nearby community of Dot Lake. Dot Lake residents have kinship and hunting ties with Healy Lake residents, and also use the Pogo Mine project area for subsistence harvests (NPS, 1995). Therefore, the harvest data for Dot Lake is described here as a representative example of Upper Tanana Athabaskan subsistence harvests. According to Marcotte (1991), Dot Lake residents use a large diversity of resources. In 1987 to 1988, the latest year for which quantitative data is available, residents of Dot Lake harvested an average of approximately 378 edible pounds of wild food per household (Table 3.18-2).

Table 3.18-2 Household Harvest and Use of Fish, Game, and Plant Resources, Dot Lake, June 1987 to May 1988

Resource	Percentage of Households					Per capita Harvest (lbs)	Mean Household Harvest (lbs)
	Used	Attempted Harvest	Harvested	Received	Gave		
All	100	100	100	87	60	115	378
Salmon	80	20	20	73	13	20	66
Non-salmon Fish	93	73	73	33	47	32	105
Big Game	93	60	33	73	20	48	159
Caribou	67	40	20	53	13	8	26
Moose	73	47	20	67	20	39	129
Black Bear	27	7	7	20	0	0	0
Small Game	73	53	53	20	13	5	15
Birds	73	60	60	40	47	2	7
Ducks	47	27	27	33	27	1	2
Grouse	53	47	47	13	33	1	4
Ptarmigan	47	33	33	13	27	1	2
Edible Plants	93	93	93	13	47	8	25
Berries	93	93	93	13	40	7	23
Plants	73	73	73	13	27	1	2
Wood	67	60	60	13	20	—	—

Source: Marcotte (1991: Table 14)

Moose composed approximately 34 percent of the total harvest, fish approximately 45 percent, and caribou seven percent (Marcotte, 1991). Three of four households used resources from all resource categories (NPS, 1994). Ninety-three percent of the Dot Lake households used fish, big game, and edible plants (including berries). Seventy-three percent of the households used small game and birds. Sharing resources was common, and 87 percent of the households received resources while 60 percent gave resources. Residents of Dot Lake indicated they preferred wild foods to store-bought foods. They considered wild food to be an important part of their culture, and wild food is an integral part of Athabaskan traditional ceremonies (Martin, 1983).

Comparing the 1987 Dot Lake subsistence harvest data with nearby communities shows that, while the species composition and percentages are similar, the per capita harvests are greater. For example, ADFG (2001) data for Tanacross, Northway, and Tetlin show that the 1987 subsistence harvests were 250 pounds per capita (51 percent fish, 35 percent moose, and 4 percent caribou), 278 pounds per capita (52 percent fish, 27 percent moose, and 5 percent caribou), and 214 pounds per capita (59 percent fish, 30 percent moose, and 1 percent caribou), respectively. Pounds of a resource harvested are not necessarily indicative of seasonal or cultural value.

Traditional Trails and Contemporary Means of Access

There are a number of well-established and long-used trails in the area between Shaw Creek and the Taylor Highway (SRB&A, 2002a). Modern students of northern Athabaskan ethnography are often in awe of the huge distances that these nomadic peoples walked in their annual subsistence round. As people aggregated into communities, the annual round of moving to different seasonal residences diminished. However, the pattern of making seasonal trips back to traditional hunting and gathering places, although more frequent in the past, still continues today. Whether walked or traveled by snow machine, these traditional trails continue to be used periodically both for travel, hunting, gathering, and trapping, as well as for access into more remote areas (SRB&A, 2002a).

Historically, people accessed wild resources from camps or semi-permanent villages located near the resource to be harvested. They traveled by dogsled, foot, and/or boat. Contemporary access is by means of automobiles, motorized river boats, ATVs, airplanes, and/or snow machines, depending on the season. Boats and canoes are the primary means of traveling to subsistence areas in the summer and fall; ATVs are used to travel to upland areas in the summer and fall; and snow machines provide subsistence access in the winter.

Social Barriers to Subsistence Access

With the influx of non-Natives into the Shaw Creek area during the past several decades, Native hunters do not go to that area as frequently as in the past (SRB&A, 2002a). This “social barrier” emerged when non-Native recreational users and sport hunters moved into an area previously used by more traditional subsistence users. The Native reaction to the influx of white persons was to avoid the area or, if Natives did use the area, to make efforts not to be seen.

Roads and Subsistence

Construction of the Alaska Highway, completed by 1943, had a substantial impact on the lives of Tanana Athabaskans. One of the primary construction camps, located in Tok, housed 5,000 personnel (Simeone, 1995). Road construction and World War II created a boom economy that caused an influx of military and civilian non-residents, and caused an increase in wage employment for local residents (primarily Alaska Natives) that changed the local hunting and trapping economy (Simeone, 1995). Several villages, including Healy Lake, Kechumstuk, and Mansfield, were abandoned as people moved closer to the road for employment. Although hunting and fishing still provided the backbone of the economy, people spent more time earning cash during the road construction boom. Once road construction was completed, few economic benefits were left for the majority of the Native people. The Alaska Highway also opened the previously isolated Upper Tanana Valley region to hunters from Fairbanks and Anchorage. The resultant increased hunting pressure led to more government regulations (Simeone, 1995). The Alaska Highway also affected Native demography and health (Simeone, 1995). Epidemic diseases caused the abandonment of villages such as Healy Lake as people moved to Tanacross and Dot Lake.

After the Taylor Highway was constructed, outside hunters took advantage of the new highway access and harvested caribou along the road (SRB&A, 2002a). The first section of the Taylor Highway was constructed along a traditional Athabaskan trail from Tetlin Junction to Kechumstuck. Once the highway was constructed, nonlocal hunters with vehicles had easy access into this area. Native hunters of North America have a long tradition of allowing the leaders of a migrating caribou herd to pass unmolested. According to this custom, once the leaders pass, the rest of the herd will follow. However, if the leaders are carelessly shot, the herd will become confused and not follow traditional pathways. This dispersing of the herd migration has a negative effect on traditional hunters who typically depend on hunting caribou along relatively predictable migration routes. Outside hunters attracted by a new road often have little knowledge of either the caribou migration patterns or behavior and eagerly shoot the first caribou they encounter. After the Taylor Highway construction, nonlocal hunters apparently shot the leaders of the Fortymile Caribou Herd, causing the herd to “split” and resulting in difficulty for local hunters to harvest in traditional locations (SRB&A, 2002a).

3.18.5 Contemporary Subsistence Use Areas and Species

Figure 3.18-1 depicts the upper Tanana Athabaskan subsistence use areas for *all* resource types. Figure 3.18-2 depicts the same information for the Pogo project vicinity. These figures present two time periods: current use area (within the last 10 years) and lifetime use area (beyond the last 10 years). The figures depict the subsistence use areas for participants in the 2001 subsistence workshop and do not represent the subsistence use areas of all residents in the Upper Tanana Valley (SRB&A, 2002a). Although Upper Tanana Athabaskan subsistence uses are the focus of this subsistence discussion, non-Natives reside in the target communities and likely conduct seasonal harvest activities in the project area. Furthermore, ADFG subsistence use information referenced in this discussion includes community practices and not solely those of Native residents.

The following discussion focuses on the individual subsistence resources harvested by Upper Tanana Athabaskans in the Pogo Mine project area. Maps and additional description to supplement the following discussion can be found SRB&A (2002a).

Fish

Fish is an important subsistence food, reflecting its year-round availability. Fish resources that are harvested in the Upper Tanana Valley include pike, whitefish, grayling, and burbot. Fishing occurs along the length of the Tanana River and in most of the major rivers, creeks, and lakes in the subsistence use area on a year round basis (SRB&A, 2002a).

One favored subsistence activity is ice fishing for pike in the winter. Pike are the first fish seen in the spring when they move out of the lakes to spawn. Whitefish exist over a large area and are easy to catch whenever they are running (generally August through October). The Goodpaster River in the middle of July is a good place to harvest whitefish and pike with a net. Burbot can be harvested from Shaw Creek to Northway along the Tanana River year-round. Salmon are harvested from the Copper and Chistochina rivers. Trout can be harvested at one of the many stocked lakes in the area, including Quartz Lake, Bird Lake, and Jan Lake. Grayling are often harvested in Clearwater Creek, Clearwater Lake, and Volkmar Lake. Ice fishing typically occurs at Lake George, Healy Lake, Volkmar Lake, Goodpaster River, and the Tanana River (SRB&A, 2002a).

Moose

Moose are an important resource for Upper Tanana Athabaskans. The lifetime use area is a large area that stretches north of the Tanana River, from the Salcha River to east of the Taylor Highway in lower lying areas (SRB&A, 2002a). Current use areas can be found along the Tanana River and the Alaska Highway from northwest of Big Delta to Tok, in the Shaw Creek Flats area, and along and around most rivers (Goodpaster River, Volkmar River, Healy River, Gerstle River, Middle Fork, and Johnson River) and lakes (Quartz Lake, Volkmar Lake, Healy Lake, Clearwater Lake, Dot Lake, Sand Lake, and Lake George) in the region. Popular moose hunting areas are along roads, rivers, and creeks, including Shaw Creek, Sand Creek, George Creek, Keystone Creek, Caribou Creek and Rapid Creek. Another area used currently is the Goodpaster River area north of Central Creek near Shawnee Peak (SRB&A, 2002a).

Moose are generally hunted in the fall (often in conjunction with waterfowl hunting), but can be considered a year-round resource, depending on need (including food and ceremonial purposes). Food is taken from the surrounding environment as need dictates. This moose harvest includes hunting for potlatches and memorial potlatches, as well as day-to-day feeding of one's family. Hunting parties usually consist of small groups of men. Moose hunting areas are often accessed by vehicle, boat, ATV, "Argo", and walking. Winter access is by snow machine. Most hunters hunt every year, and often several times a year. A popular hunting method is to travel by boat, for example from Healy Lake to Lake George on the Tanana River, or from Delta to Healy Lake, or from Dot Lake to Lake George (SRB&A, 2002a). The Dot Lake moose hunting area extends into the Pogo Project area (SRB&A, 2002a).

Caribou

Caribou hunting areas are extensive and reflect the widespread distribution of the animals and the changes in migration patterns and population over time (SRB&A, 2002a). Hunters use the area west and northwest of Mount Harper (Figure 3.18-1). This area is often reached by snow machine in winter. Recent hunting for caribou also occurs along both sides of the Taylor Highway. "Stray" caribou are harvested in the Shaw Creek area, as they were harvested 50 years ago. Other recent use areas include the Goodpaster River near its confluence with the Tanana River and the South Fork, the Macomb Plateau (south of the Alaska Highway, south of Lake George), and along the Alaska Highway between Sand Lake and the Robertson River. The caribou lifetime use area encompasses the Goodpaster River and the area north of the Goodpaster River, an area east and north of the Tanana River between the Goodpaster River and Sand Lake, an area between Kechumstuk and Mansfield, and an area south of the Alaska Highway between the Johnson River and Dot Lake (SRB&A, 2002a). The Dot Lake hunting area extends into the Pogo Project area encompassing the Goodpaster River and Shaw Creek drainages (SRB&A, 2002a; NPS, 1995).

Hunting for caribou generally begins in late summer or early fall (before rutting season) and the winter (generally cows). Caribou hunting parties are generally composed of small groups (two to four) of men. Hunters access this resource by boat, ATV, walking, or by road in the fall and snow machines in the winter. Often, combinations of methods are used. Some hunters fly to the hunting area (SRB&A, 2002a).

Pogo Mine EIS

Figure 3.18.1

Upper Tanana Athabaskan Subsistence Use Areas for All Resources

map prepared by
Stephen R. Braund & Associates

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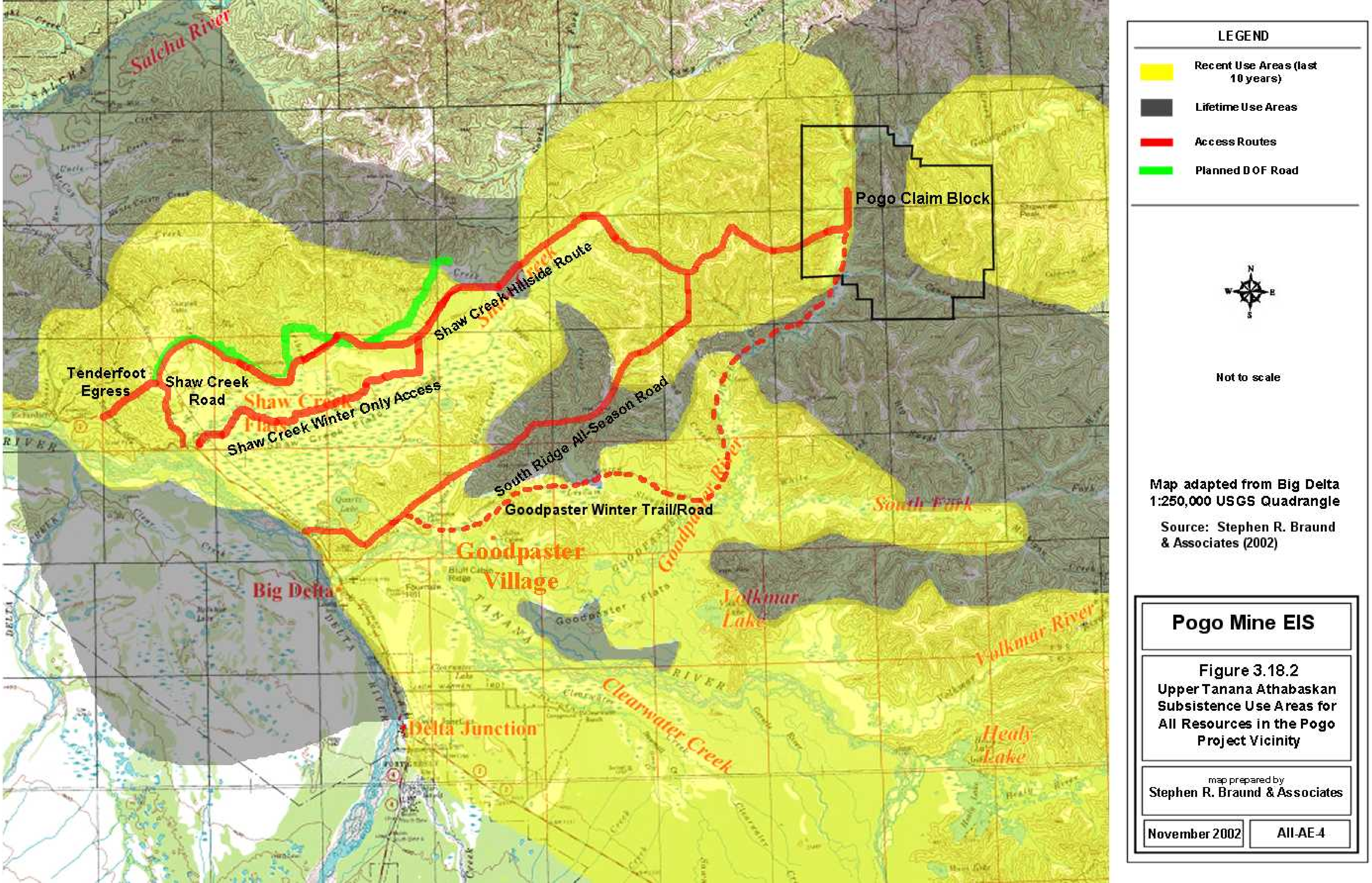


Figure 3.18.2
Upper Tanana Athabaskan Subsistence Use Areas for All Resources in the Pogo Project Vicinity

Upper Tanana Athabaskan subsistence users noted historic caribou calving and migration routes in the Mount Harper-upper Goodpaster River area (SRB&A, 2002a). These calving areas extend farther southwest than those depicted by the FCHPT (2000), but the time periods are different. The FCHPT information is primarily from the early 1990s to the present, whereas the local information represents a much earlier time period, extending back to the 1940s and 1950s. Local hunters noted that caribou migration patterns have changed over time. Whereas caribou migrated near Healy Lake in the past, this migration was disrupted beginning in the 1960s when nonlocals began to hunt caribou in the area, shoot the leaders, and consequently alter caribou migration patterns. It is only recently that caribou have returned to the Healy Lake area (SRB&A, 2002a).

Upland Birds

Hunting for upland birds generally occurs in the fall (August/September) at the same time as berry and waterfowl harvests. Access is generally by automobile, walking, or both in the fall and snow machine in the winter. Species harvested are spruce grouse in the fall and other grouse and ptarmigan in the winter. Hunting for upland birds occurs along the “edge of the hills.” Recent use areas (last 10 years) are concentrated in areas such as the Shaw Creek Flats, along the Tanana River west of Quartz Lake and between Volkmar Lake and the Robertson River, in the area at the confluence of the Goodpaster and Tanana rivers, along the Goodpaster River and the South Fork, along the Volkmar and Healy Rivers, and around area lakes (e.g., Healy Lake, Lake George, and Sand Lake) (SRB&A, 2002a). The lifetime use area is much larger, and extends from the Shaw Creek Flats south to the Robertson River and east of Joseph. This lifetime use area is associated with the opportunistic nature of subsistence hunting in which upland birds may be harvested as they are encountered while individuals are pursuing other activities such as traveling, or hunting other species such as moose and caribou (SRB&A, 2002a).

Waterfowl

Waterfowl are also an important subsistence resource The waterfowl hunting season generally occurs in the spring and the fall, and often occurs in conjunction with moose and upland bird hunting. Hunting for waterfowl occurs along area lakes, rivers, and creeks. Access to the resource generally occurs through the use of boats, walking, or both. Waterfowl are harvested in all of the area lakes (Volkmar, Healy, George, and Sand lakes), at Shaw Creek Flats, on the Tanana River between its confluence with the Delta River to south of Tetlin Junction, on the Volkmar and Healy rivers, and along area creeks such as Mansfield and George creeks (SRB&A, 2002a).

Sheep

Sheep hunting usually occurs in the late summer/early fall and fall seasons. Sheep hunting occurs in the area around Mount Harper and areas south of the Alaska Highway such as Granite Mountain, Independent Ridge, and the Macomb Plateau (SRB&A, 2002a). Access to these areas is generally by traveling up the creeks and rivers (SRB&A, 2002a). The Dot Lake sheep hunting area extends into the Pogo Mine project area (SRB&A, 2002a).

Bear

Black bears are the primary bear species hunted in the Upper Tanana Valley. Areas hunted over time include the area surrounding the Goodpaster Village site near the confluence of the

Tanana and Goodpaster rivers, the area near the confluence of the Tanana and Gerstle rivers, Lake George, Sand Lake, and an area south of the Robertson River (SRB&A, 2002a). The Dot Lake bear hunting area extends into the Pogo Mine project area (SRB&A, 2002a).

Berries

Species of berries that are harvested in the fall include blueberries, cranberries, raspberries, black berries, salmon berries, high-bush cranberries, and currants. Wild rhubarb is also harvested at the same time. Berries are typically harvested during caribou or moose hunting. Berry harvest areas include the confluence of the Goodpaster and Tanana rivers, along the Tanana River at Shaw Creek Flats, along the Tanana River between Johnson Slough and Chief Creek, along the Volkmar River, and around most lakes in the area (Healy Lake, Lake George, Sand Lake, Dot Lake, and Lake Mansfield) (SRB&A, 2002a).

Plants Used for Traditional and Ceremonial Purposes

Plants used for traditional and ceremonial purposes include sweet grass and juniper. Sweet grass is used in steam baths and in tea. The juniper plant has leaves that are used in the steam bath and in draughts for coughs and rheumatism. Use areas for plants include an area along the Tanana River west of Shaw Creek Flats, an area along the Tanana River southwest of Quartz Lake, along the Tanana River south of Volkmar Lake, an area between the Volkmar River and Healy Lake, along the east coast of Twelvemile Lake, along the Tanana River south of Lake George and Sand Lake, near the confluence of the Tanana and Robertson rivers, and on the southern shore of Lake Mansfield (SRB&A, 2002a).

Minerals Used for Traditional and Ceremonial Purposes

Red "paint" gathered at specific locations was traditionally used as a sealant or coating on snowshoes and sled runners, as "war paint," and as a trade item for copper. Traditionally, the sources of the paint were "protected" information. Mount Harper is one source for this paint (SRB&A, 2002a). Different groups had different colors; for example, Salcha and Goodpaster – orange paint; Healy Lake – red paint; Gwich'in – light blue) (SRB&A, 2002a).

Trapping

Because of low fur prices, trapping is currently not a widespread practice. This activity occurs in the winter between November and March or April. Areas of recent use (last 10 years) are from the general area of Healy, George, and Sand lakes, extending northeast up the rivers as well as other discrete lowland areas (SRB&A, 2002a). Lifetime use areas encompass a larger area, including the major rivers and creeks such as Shaw Creek, Goodpaster River, and Tanana River. Species harvested during trapping activities include marten, wolverine, wolf, coyote, lynx, fox, beaver, muskrat, mink, and weasel (SRB&A, 2002a).

3.18.6 Summary

Subsistence harvest and the use of natural resources continue to play a vital role in the economy and culture of the Tanana Athabaskans in the Upper Tanana region. Current Athabaskan residents, including part-year residents, of Healy Lake, Dot Lake, Delta Junction, Tanacross, Northway, and even Fairbanks, with historical and kin-associated relationships to the study area continue to harvest traditionally used fish, moose, caribou, upland birds, waterfowl, small fur-bearing mammals, sheep, bear, berries, plants, minerals, and small furbearers in the Pogo Mine project vicinity. Reciprocal family and hunting relationships continue to play a role in the subsistence practices of Upper Tanana communities of Healy Lake, Dot Lake, Delta Junction, Northway, and Tanacross, and also kin who live in Fairbanks.

3.19 Cultural Resources

3.19.1 Prehistoric and Contact Period Resources

The middle Tanana River is a portion of the unglaciated Beringia Refugium of the late Pleistocene era, and because of this aspect of the paleoecology, it possesses high potential for containing some of the earliest traces of humans on the North American continent. Traces of early man in the vicinity of the proposed project exist at Broken Mammoth, Swan Point, and the Mead site (Yarborough, 2000). In a clear example of the area's important archaeological potential, mammoth ivory was worked into tools at Broken Mammoth (Holmes, 1996). One of the earliest cultural traditions in the North American Arctic, the American Paleoarctic tradition, is represented in the buried deposits more than 10,000 years in age at the three sites named above. The sites in the area containing remains of Pleistocene fauna in association with human tools are some of the most important in North America (Holmes, 1996; Cook, 1996). They offer opportunities to not only gain insights into ways early man coped with a considerably different world than that of today, but to obtain important insights into the ways humans adapted to environmental changes that occurred at the end of the last ice age.

As the Holocene era progressed, cultural changes that occurred in the region as a whole included the initial appearance of Northern Archaic culture at around 6,000 years ago in some areas of Alaska (NPS, 1998). Many questions concerning Northern Archaic cultural development remain to be answered by both new discoveries of the traces left by the Northern Archaic people and new interpretations of data. Specific issues include the nature of relations between Paleoarctic culture and the Northern Archaic. In the project area, indications are that people were absent for some time following the tenure of the Paleoarctic tradition (Yarborough, 2000). Nevertheless, there are indications that some type of relationship may have existed in technological elements such as the Paleoarctic type of blade and core technology that is also documented at sites with what are otherwise characteristic Northern Archaic tools.

A recent synthesis of Northern Archaic origins suggests that the culture spread as a diffusion of characteristic tool forms such as the Northern Archaic notched points that were accepted in varying degrees by different groups in the region (NPS, 1998). The overall distribution of the technology indicates that the diffusion cross-cut different cultures and language groups during mid-Holocene times. Many important questions remain concerning Northern Archaic culture. For example, what were the temporal, cultural, and possibly environmental factors that supported the development of a distinctive Northern Archaic technology while enabling the persistence of an important technological element of Paleoarctic culture? Answers to questions such as this may be contained in the archaeological deposits of undiscovered sites in the project area. Examples of sites containing Northern Archaic remains in the vicinity of the project area are the Campus site and Dixthada (NPS, 1998).

Changes that took place in the environment over the past 6,000 years undoubtedly affected the human inhabitants of the region in ways that are only poorly understood. The emergence of the Athabaskan culture of the Alaskan interior is thought to be directly traceable to Northern Archaic origins by some (NPS, 1998). Nevertheless, by 2,000 years ago, identifiable Athabaskan cultural patterns had emerged in some interior areas. There is yet much to be learned about the ethnogenesis of Athabaskan culture and the environmental and cultural influences that contributed to its development. In this regard, an important question is: Did environmental and cultural changes that occurred during the past 6,000 years have impacts that were sufficient to either precipitate changes in technologies such as house construction, or could the changes have resulted in a withdrawal of humans from the area until conditions ameliorated? An important natural event that occurred during this time to the southeast of the project area, the eruption of Mt. Bona around AD 1250, is an example of a sudden environmental episode that undoubtedly had an impact on the residents of the upper and middle Tanana River area (NPS, 1998). Related questions are, Did this event result in a temporary abandonment of the area by humans? What were the effects of the eruption on the environment in the project area?

Climatic periods of glacial maximum and minimum expansions during the Holocene are well documented in northern regions, and their effects on the cultures at different stages of prehistory remain major avenues of inquiry in studies of northern prehistory. Plant communities and general climatic patterns had stabilized by around 6,500 years ago (NPS, 1998), but fluctuations in temperatures and environmental shifts of smaller magnitudes nevertheless affected the human inhabitants of the region to some degree. Related questions are, How did the prehistoric ancestors of the historical Athabaskan inhabitants adapt to climate changes, such as the Little Ice Age that began around AD 1450? What other factors operating in prehistoric times contributed to the ethnogenesis of the Native culture encountered by the first European explorers? The historic Tanana Athabaskan sites in the area undoubtedly contain information that would provide illumination for these areas of inquiry.

The traditional territory of the Tanana Athabaskan tribe roughly corresponded with the Tanana River drainage and extended westward to the confluence of the Kantishna and Tanana rivers, north to the headwaters of the Tolovana River, and to the southeast to the northern slopes of the Wrangell Mountains (NPS, 1998). A total of five bands with their respective territories composed the Tanana tribe. The area of the proposed project includes portions of the Goodpaster and Healy River-Joseph bands (McKennan, 1981).

Historical Tanana Athabaskan patterns of land use reflect both ways in which game animals and other types of resources were used by the inhabitants through the different seasons of the year, as well as the beliefs and perceptions the inhabitants had concerning property and social organization. An overall, general pattern was for the territory or range of a regional group to include a major stream or river. Lands behind the river provided the territorial “hinterlands” that, in combination with the river, usually contained the major array of resources that would be used by the group through an annual cycle (NPS, 1998).

Site types within a given territory ranged from winter settlements to hunting and fishing camps, and to other types of temporary use locations where specific resources occurred, such as moose or caribou ranges and berry-picking areas. The boundaries of the territory were recognized by the inhabitants of adjacent territories, on the basis of traditional, customary use of the land by the resident group (Holmes, 1975).

The primary focus of Tanana subsistence during the summer months was on several species of salmon taken with fish traps and dip nets from weirs constructed across lake outlets; whitefish were also important (McKennan, 1981; Yarborough, 2000). Other resources used during the late summer included berries, roots, and waterfowl. In the fall, the focus shifted to caribou migrating into the uplands; caribou fences and corrals were constructed for harvesting the animals with bows and arrows (McKennan, 1981). Caribou meat was dried for the winter months. In addition to fish and caribou, sheep were hunted in late summer and moose were taken during times the bands were at lower elevations, during the spring, summer, and fall. Winters were spent at upland locations.

While social organization within a territorial group was by and large egalitarian, leaders or chiefs emerged at such times when persons were needed to fill roles in which coordination of activities was required (U.S. NPS, 1998). Examples of this type of leadership can be seen in coordinated hunting efforts such as caribou drives and similar activities. In addition, a big chief sometimes emerged within a territory as a person vested with the responsibility of negotiating treaties with neighboring groups, or as one who spoke for the group in matters of trade and other types of negotiations. The home village of such a person was sometimes regarded as the principal village in the territory. Important villages in the project area are *Jiizechagge* (Goodpaster Village) and *Tathchagge* (Big Delta) (Yarborough, 2000). In the context of the preceding discussion, it is likely that important chiefs lived in each of the villages, a circumstance that may have been especially important socially because the two villages were located in territories of different bands (McKennan, 1981; Yarborough, 2000). Although the two villages may have functioned as fish camps during the summer months in late precontact times, contact period descriptions suggest that Goodpaster Village at least showed evidence of winter habitation (Yarborough, 2000; Mishler, 1986). Winter settlements were supposedly located in the uplands, presumably in the higher elevations, and away from the river, based on ethnographic information (McKennan, 1981).

Historic Tanana Athabaskan sites in the vicinity of the project have been documented by Andrews and Mishler (Yarborough, 2000). Sites documented in the project area as a result of these efforts include Goodpaster Village (*Jiizechagge)* and two "village" sites on Shaw Creek, and a number of names that distinguish locations and areas with cultural importance in the project area. Included here are areas along the Goodpaster River, Shaw Creek, Quartz Lake and Thompson Lake, Indian Creek, Thompson Hill, and the bluff on which the Mead site is located (Yarborough, 2000). Yarborough notes that some of these cultural resources may be eligible for the National Register of Historic Places as "traditional cultural properties."

3.19.2 Historic Environment

Exploration of the area began in 1885 as part of an expedition led by Lieutenant Henry Allen of the U.S. Army (Yarborough, 2000). Little or no contact occurred between the Euroamericans and the Natives during this expedition. Although missionary activities in the region between 1891 and 1892 undoubtedly resulted in contacts with the inhabitants of Goodpaster Village and Big Delta, scant documentation of the encounters exists (Mishler, 1986). A subsequent military expedition in 1898 actually resulted in the first visit to Goodpaster Village (*Jiizechagge*) by Allen and by another military expedition led by Castner (Mishler, 1986; Yarborough, 2000). Important results of these trips were some of the first descriptions of the inhabitants of the area.

Alfred Brooks also visited Goodpaster Village in 1898 during a geological survey of the Tanana River. Although he wrote little in the way of description, he did take the first photographs of the village (Mishler, 1986). Also of import is Brooks' encounter with white prospectors who were preparing to travel to the upper Goodpaster; their expedition appears to constitute the initial mining activity in the area (Mishler, 1986). It is important to point out the 1898 documentation by Castner (Mishler, 1986) of village residents possessing rifles. Rifle possession was undoubtedly a reflection of the Goodpaster Natives' participation in the fur industry on the lower Tanana River. These types of artifacts, including trade beads and similar items, are the first physical evidence of Euroamerican presence in the area.

Activities related to historical mining in the Tanana River Valley began around 1870 as part of the transitory gold rush activities in the vicinity of the Yukon River, with a subsequent major discovery on the Klondike in 1898-1999. Prospectors began exploring the Tanana River Valley early in the process – by the 1870s (Alaska Environmental Information and Data Center, 1974; Saleeby, 2000). By 1873, a trading post had been established on the Yukon River at the mouth of the Tanana River and provided support for the mining developments in the region. During the early years of the enterprise, the explorations and travels of prospectors were extensive, but for the most part undocumented. An exception to this rule was an incident recorded by Castner during his explorations in the Tanana River area in 1898. In this account, he reports rescuing two white men – presumably prospectors – who had traveled from Dawson in the Yukon Territory, by way of Fortymile, Lake Mansfield, Ketchumstuck Hills, and the Tanana River. One of the prospectors related to Castner that he had prospected up the Volkmar River 50 miles, presumably in search of gold (Castner, 1900). None of the cultural resources sites recorded to the present for the project area contains remains of the early gold rush activities in the region.

A military project begun in 1902 also produced remains with historical importance. In that year Lieutenant Billy Mitchell surveyed a route for installation of a section of the WAMCATS between Eagle and Tanana (Yarborough, 2000). The purpose of this project was to provide communication between army posts in Alaska and Washington, D.C. A segment of the route of the line follows the course of the Goodpaster River in the project area. In 1938, a miner began hauling freight over a winter trail that may have been used previously by dog mushers (Yarborough, 2000). Subsequent use of the Goodpaster River Valley was related to mining operations in the upper drainage, with the primary function being a route for hauling freight and supplies.

Historical hardrock development and mining activity in the upper Goodpaster region occurred primarily in the Black Mountain area, approximately 20 miles east of the area now known as Pogo, on four small quartz vein lodes during the period from 1936 to 1941. The historic lodes included the Blue Lead, Blue Lead Extension, Grey Lead, and Grizzly Bear. Total production was approximately 1,150 oz (Tweiten, 1990). Between 1990 and 1994, these historic properties were consolidated into a single claim block, now known as the Rob property, and have been further explored since 1995 without the delineation of important new gold resources (Teck-Pogo Inc., 2003).

3.19.3 Project Area Sites

Table 3.19-1 lists the cultural resource sites in the project area, and within the area of potential effect (APE). These sites were identified from the Alaska Heritage Resources Survey (AHRS) files in the State Historic Preservation Office (SHPO, 2002), baseline field reconnaissance surveys commissioned by the Applicant (Yarborough, 2000 and 2001), and direct consultations with Native organizations and individuals (Harritt, 2001). There are no ANCSA Section 14(h)(1) sites located in the APE.

Table 3.19-1 Archaeological and Historical Sites in the General Project Area

AHRS Site No.	Site Name	Site Type	Period/Date
XBD-003	Central Telegraph Station	Communication Site, U.S. Army Signal Corps	Historic, Euroamerican AD1903
XBD-004	Campbell Cabin	Log trapping cabin	Historic, Euroamerican AD1903
XBD-013	Rosa Creek Cave	Rock shelter	Prehistoric
XBD-014	Shaw Creek I	Site/ Fish camp/ Fish wheel/ Garden	Prehistoric/Historic, Athabaskan
XBD-015	Shaw Creek II	Site, graves, and caches	Prehistoric/Historic, Athabaskan
XBD-016	Shaw Creek Summer Camps	Summer fishing camp with fish traps	Protohistoric/Historic, Athabaskan
XBD-017	Tanana River Site	Site/ "Indian Camp"	Prehistoric
XBD-018	Quartz Lake	Site (artifacts along shore)	Prehistoric
XBD-019	Indian Creek Cache	Cache site	Prehistoric
XBD-031	Koppenhaver	Lithic scatter	Prehistoric
XBD-041	Lost Lake Site	Log structure	Historic, Euroamerican AD1904
XBD-051		reported site	
XBD-053	Seppala Cabin	Cabin and out structures	Historic, Euroamerican AD1940-1950s
XBD-054	Henry "Butch" Stock's Roadhouse (Alonzo Maxey's Roadhouse)	Roadhouse	Historic, Euroamerican AD1904-1930
XBD-055	Sternwheeler S.S. Nabesna	Shipwreck	Historic, Euroamerican AD1900s
XBD-057	Nigger Bill's Roadhouse	Roadhouse	Historic, Euroamerican AD1900s
XBD-059	Ben Bennett's Trading Post	Village	Historic, Athabaskan
XBD-060	Bert and Mary Hansen's Roadhouse	Log Structure, roadhouse dismantled 40 years ago	Historic, Euroamerican AD1900s
XBD-063	Tenderfoot Roadhouse	Roadhouse/Store	Historic, Euroamerican AD1912
XBD-071	Mead Site	Site (2 components)	Prehistoric
XBD-072	Quartz Lake I	Site	Prehistoric
XBD-073	Thompson Lake Site	Site	Prehistoric
XBD-074	Bluff Cabin Ridge Site	Site	Prehistoric
XBD-075	Goodpaster Sawmill Site	Sawmill	Historic, Euroamerican AD1900s
XBD-076	Goodpaster Cabins Site	Three cabins	Historic, Euroamerican AD1900s (early)
XBD-077	Goodpaster I	Site/Artifacts/Hearths	Protohistoric/ Historic, Athabaskan
XBD-081	Goodpaster II Jiizechagge or Old Goodpaster Village)	Cache pits/"Abandoned village"	Historic Athabaskan AD1902
XBD-092		reported site (no info in AHRS)	
XBD-125	Big Delta Cremation Ground	Burial/Sacred site	Historic Athabaskan
XBD-130	BM "Shaw"	reported site (no info in AHRS)	
XBD-131	Broken Mammoth Site	Site/ Camp (multicomponent)	Prehistoric 11,770+/-210BP-2,040+/-65BP
XBD-132*	Big Delta Historic District	District (Includes sites: XBD-059, XBD-133-154)	Historic, Euroamerican AD1904-1941
XBD-155*	Lithic Site	Site/Artifacts	Prehistoric
XBD-156	Swan Point	Site/Camp (multicomponent)	Prehistoric/ Historic, Athabaskan 12,060+/-70BP to 1,220+/-70BP
XBD-157	Lithic Site	Site/Lithic scatter	Prehistoric

Table 3.19-1 Archaeological and Historical Sites in the General Project Area

AHRS Site No.	Site Name	Site Type	Period/Date
XBD-158	Lithic Site	Site/Lithics	Prehistoric
XBD-159	Quartz Lake	Site, artifacts eroding out of bluff	Prehistoric
XBD-160	"Activity Area"	Site	Prehistoric
XBD-161	"Activity Area"	Site	Prehistoric
XBD-170	Prehistoric Site	Site, lithic	Prehistoric
XBD-171	Prehistoric Site	Site, lithic	Prehistoric
XBD-172	Tenderfoot Creek Boiler & Driftmine Site	Mining	Historic, Euroamerican AD1910s
XBD-173	Tenderfoot Creek Log Cabin & Bridge Site	Mining/Bridge/Cabin	Historic, Euroamerican AD1910s
XBD-182	Hearth Feature	Fire cracked rock/Calcined bone	Prehistoric, 360+/-60BP
XBD-184	Surface Feature	Surface feature	Prehistoric
XBD-185	Rock Cairn	Rock cairn	
XBD-190	Shaw Creek Village (1)(UTN 34-1)	Village	Protohistoric/Historic Athabaskan
XBD-191	Shaw Creek Village (2)(UTN 34-2)	Village	Protohistoric/Historic Athabaskan
XBD-197	Fowler Farm Archaeological Site 1	no further information available	
XBD-198	Fowler Farm Archaeological Site 2	no further information available	
XBD-199	Fowler Farm Archaeological Site 3	no further information available	
XBD-200	Fowler Farm Archaeological Site 4	no further information available	
XBD-235	Gilles Creek	Prehistoric Site in Pogo Area	Prehistoric
XBD-238		Graves	Historic, Athabaskan
XBD-239		Graves	Historic, Athabaskan
XBD-240		Graves	Historic, Athabaskan (ca. AD1912)
XBD-241		Fishing and trapping location	Historic, Athabaskan (AD1947-1950)
XBD-242		Graves	Historic, Athabaskan
XBD-243		Camp and cemetery	Historic, Athabaskan (ca. AD1914-1953)
XBD-244	John's Camp	Camp	Historic, Athabaskan (ca. AD1914-1950s)
XBD-245		Fish camp with fish wheel	Historic, Athabaskan (ca. AD1920s)
XBD-246	Trapping Camp	Trapping Camp	Historic
XBD-247		Fire cracked rock	Prehistoric

* Listed on the National Register of Historic Places

Source: AHRS

3.20 Visual Resources

Visual resources, and their analysis, address the importance of the inherent aesthetics of the landscape, the public value of viewing the natural landscape, and the contrast or change in the landscape from proposed project alternatives. Existing visual quality, constituents, landscape visibility and scenic classes, and visual absorption capability are commonly used to describe the affected visual environment.

3.20.1 Existing Visual Quality

Ecological unit descriptions (EUDs), or "mapping units," were determined for the project area by Adams (2000). Procedures for determining elements of the EUDs, including landscape character, scenic attractiveness, and scenic integrity, followed U.S. Forest Service (1995). Figure 3-20.1 presents the EUDs for the Pogo Mine project area.

The Shaw Creek Foothills area is characterized by rolling foothills with rounded slopes. Specific creeks within the unit include Keystone, Caribou, and Gilles creeks. The area has a southwest aspect with elevations varying from 1,200 at the base to roughly 2,000 ft AMSL.

The scenic attractiveness of the Shaw Creek Foothills EUD is described as "typical" of the area. There are no outstanding features that add variety or vividness. The area is almost completely natural with no cultural patterns that contribute positively or negatively to the viewed landscape. The scenic integrity of the unit, in general, is very high.

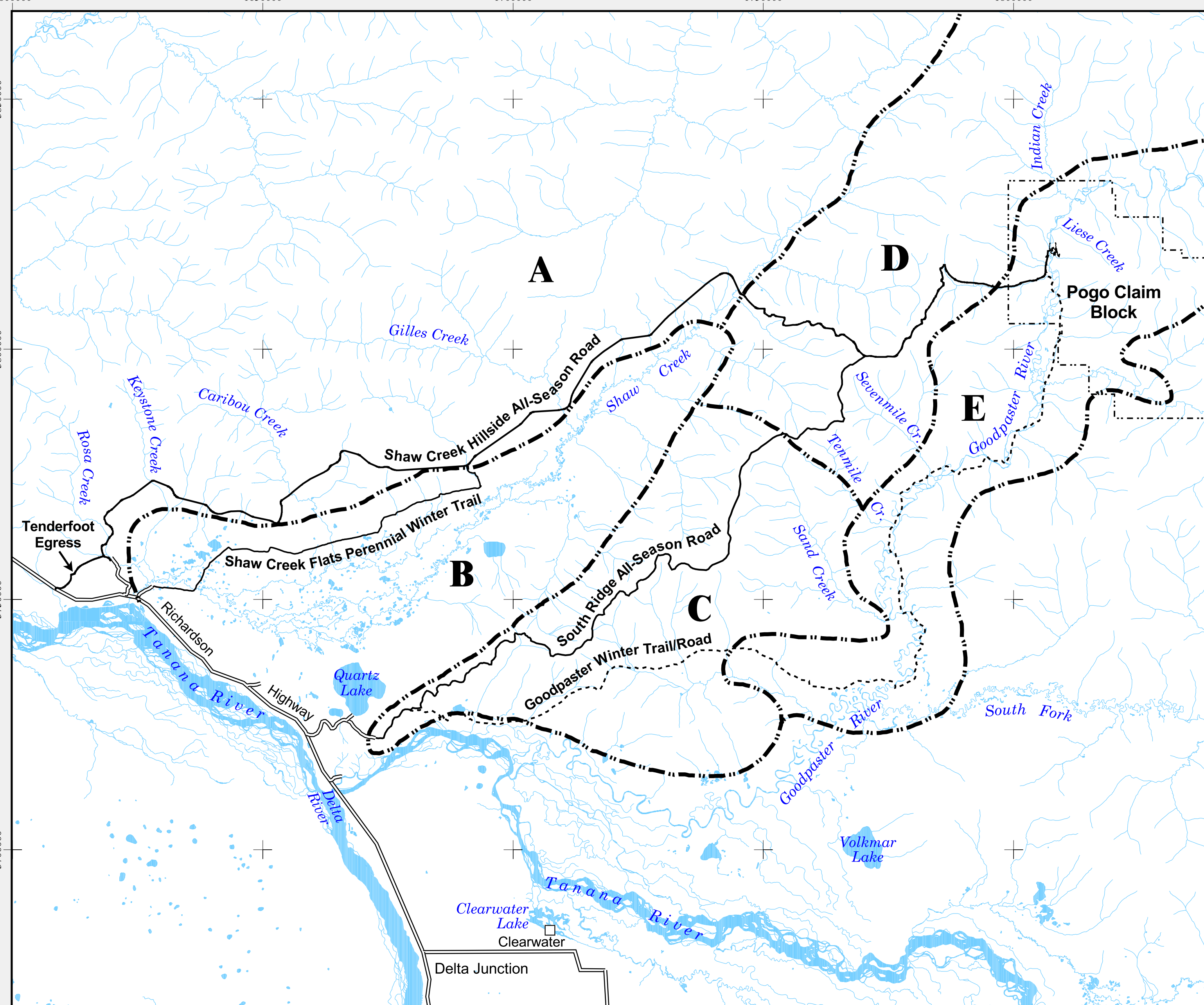
Shaw Creek West Foothills EUD

View towards Shaw Creek foothills

View of Shaw Creek foothills above the flats

The lower elevations of the Shaw Creek Flats EUD are characterized by level terrain with small lakes, ponds and wetlands. Shaw Creek is the dominant Creek in the valley with numerous small meandering creeks and interconnected water bodies.

The scenic attractiveness of the Shaw Creek Flats EUD is described as "typical" of valleys that feed into the Tanana River Valley. The infrastructure improvements at Quartz Lake, the Trans-Alaska Oil Pipeline, the Richardson Highway, and the power and telecommunications lines are found in the southern and western margin of the EUD, but are relatively minor intrusions into the unit as a whole; therefore, the overall scenic integrity of the area remains very high.



Pogo Mine EIS

Figure 3.20-1
Project Area
Ecological
Unit Descriptions

map prepared by:
ABR inc.
environmental research & services

1 Aug 2002 | File: Pogo_PDEIS_Ch3-4_EUD_ROS.apr

Shaw Creek Flats EUD

Shaw Creek Flats from Richardson Highway

Shaw Creek Flats near the Trans-Alaska Pipeline

The Lower South Ridge EUD is composed of the lower hillsides of the ridgeline that divides the Shaw Creek and the Goodpaster River valleys. Tenmile Creek defines it to the northeast, as does the valley north of Corda Creek. Named creeks include Liscum Slough, Progressive Creek, Sand Creek, and Tenmile Creek, which all drain into the Goodpaster River, and Rapid, Eagle and Corda creeks, which drain into Shaw Creek.

The area is characterized by low hills rising from approximately 1,000 ft AMSL to relatively high domes. A portion of the lower Goodpaster Winter Trail is in this EUD. Shaw Creek Dome, at an elevation of 3,630 ft AMSL, is the dominating element of the unit. The lower hillsides in this EUD are considered “typical” in visual attractiveness, while Shaw Creek Dome and its related topographical elements are considered “distinctive.”

Lower South Ridge EUD

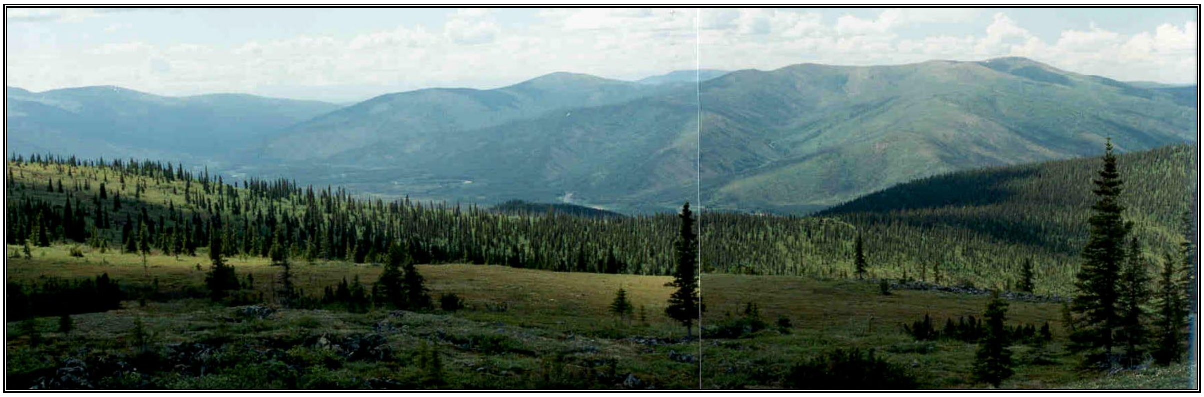
Shaw Creek Dome from Liscum Slough

Goodpaster Winter Trail at Progressive Ck.

The Upper South Ridge EUD includes the lower and upper hillsides and ridgelines of the South Ridge, between the Shaw Creek Valley and the Goodpaster River Valley. This EUD features a continuous ridgeline with elevations that range between 2,500 and 4,000 ft AMSL. Unlike the Lower South Ridge EUD, the upper ridgeline has no distinctive peaks or valleys.

Typical of upper elevations in the Tanana River Valley, the hills provide a strongly unifying element that is clearly distinctive. The bare peaks draw attention and provide uniqueness within the setting. There are no intrusions, such as roads or structures visible from the air or from other locations in the adjacent valleys, in this EUD; therefore, it is considered to have a high level of scenic integrity.

Upper South Ridge EUD



View of Goodpaster River Valley with South Ridge in background, looking westward from Tabletop at the proposed Pogo Mine site.

The Goodpaster River EUD is composed of the lower hillsides and drainages that form the Goodpaster River, which is a meandering clear-flowing stream with no altered portions along its length. Numbers of creeks flow into the river, with the South Fork of the Goodpaster River being the most distinct. The character and dominance of the river within the setting provides a very distinctive landscape.

The Goodpaster River area includes approximately 80 property households with more than 50 cabins located on or along the banks of the river, mostly south of the South Fork (Teck-Pogo, 2000d). Many of the cabins are visible from the river and also provide access and unobstructed views of the river as well. A substantial portion of the Goodpaster Winter Trail route is located in this EDU. The Pogo Mine site contains the only other recognizable alteration in this unit. A group of trees prevents a view of the present mine operations from the river; but operations are readily visible from the air. This EDU has very high scenic integrity for those portions of the unit without cabins or visible mine improvements.

Goodpaster River EUD

Lower Goodpaster River

Upper Goodpaster River near 1525 Portal (at left)

3.20.2 Constituents

The following have been identified as members of the public that may have a concern for visual resources in the project area (Adams, 2000):

- Cabin owners along the Goodpaster River
- Residents and travelers along the Richardson Highway
- Residents and travelers along Shaw Creek Road
- Clearwater Lake residents and visitors
- Goodpaster Winter Trail users
- Quartz Lake residents and visitors
- Other recreational users of the area

Concern levels for the majority of these constituents were rated as "high" (Land Design North [LDN], 2000). Many of these constituents value remoteness and have a high regard for the scenic integrity described above under "Existing Visual Quality."

3.20.3 Landscape Visibility

In general, the background views within the project area, such as those seen in the South Ridge and Shaw Creek Foothills EDUs, have a "high" constituent concern level and a "very high" scenic integrity classification. These background views include those from the Shaw Creek Flats, the Goodpaster River, and the Richardson Highway areas.

Similarly, the foreground views of the Goodpaster River corridor and area surrounding Quartz Lake also have a "high" constituent concern level and a "moderate" to "very high" scenic integrity classification. These foreground views include those from the Goodpaster River, the Goodpaster Winter Trail, and Quartz Lake.

3.20.4 Visual Absorption Capability

Visual absorption capability (VAC) refers to the ability of a landscape to accommodate human alteration. In general, LDN (2000) made the following conclusions about the project area:

- Shaw Creek Flats, Goodpaster Flats, and Liscum Slough have high VAC due to their flatness and well-screened locations.
- Thompson Lake and the Indian Creek, Corda Creek, and Rapid Creek drainages have high VAC also due to their flat topography at lower elevations.
- Quartz Lake has low VAC due to its accessibility and inability to accept alterations without loss of character and scenic condition.
- Hillsides below approximately 1,250 ft AMSL have high VAC because they are screened from the Richardson Highway by existing vegetation.
- Steep slopes, such as Shaw Creek Dome and other areas of the South Ridge, have low VAC because they are susceptible to erosion and road cuts are likely to be more visible.
- Slopes along the Goodpaster River have high VAC as long as a vegetative buffer of 150 ft is maintained at the river's edge. The effectiveness of this technique, however, varies with respect to slope, elevation, and proximity of a viewer.

3.21 Recreation

Interior Alaska offers a wide range of year-round outdoor recreation activities and opportunities that are considered extremely valuable and important to local residents and visitors to the area. Local and other residents from the greater Fairbanks area use the project area for recreation, and income is also provided from tourism activities based on recreational opportunities. Recreational activities occur throughout the project area and largely involve dispersed recreation such as hunting, trapping, fishing, hiking, skiing, snow machining, river boating, canoeing, dog mushing, and other private and commercial activities. Although recreational use is dispersed throughout the project area, several primary use areas can be identified.

3.21.1 Recreation Areas and Activities

Goodpaster River Valley

The Goodpaster River is an important recreational resource in the project area. Local Delta region and Fairbanks residents own approximately 63 cabins as well as other undeveloped recreational parcels along the lower 60 miles of the river. Four recreational users currently spend considerable time at their cabins year-round; three of these are located near the farthest downstream location where the historic winter trail crosses the Goodpaster River. The fourth is a trapper whose cabin is located downriver from the confluence of the Goodpaster River and Central Creek (Korvola, 2000a).

The Goodpaster River also is used for hunting, trapping, fishing, hiking, skiing, snow machining, dog mushing, river boating, and floating by Delta region and other interior Alaska residents, as well as owners of recreational properties in the project area. Year-round use of the upper Goodpaster drainage above Central Creek appears to be light; however, there has been increased recreational activity near the confluence of Pogo Creek and the Goodpaster River during the September moose hunting season (Korvola, 2000a).

In addition, the Goodpaster River supports an important fishery, primarily for grayling, but also for northern pike, burbot, and round whitefish. The majority of anglers are Goodpaster cabin owners or residents of the Delta Junction area (Korvola, 2000a). Table 3.21-1 presents the five primary species of fish harvested in the Delta region during specific months of the calendar year.

Table 3.21-2 presents angler days from 1996 through 1998 and the number of recorded graying harvested from the Goodpaster River. Table 3.21-3 presents the calendar of hunting and trapping in the Delta region, and Error! Reference source not found. presents big game hunting effort in the Shaw Creek and Goodpaster drainages.

Table 3.21-1 Calendar of Fishing by Species in the Delta Region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Whitefish	*	*	*	*	*	*	*	*	*		*	*
Burbot	*	*	*	*	*	*	*	*	*	*	*	*
Pike	*	*	*	*	*	*	*	*	*	*	*	*
Grayling			*	*	*	*	*	*	*			
Salmon									*	*	*	

Darbyshire & Associates (1980), Ridder (2002)

Table 3.21-2 Goodpaster River Sport Fish Effort and Harvest, 1996 to 1998

Year	Angler Days	Grayling (all lengths)
1996	1,244	835
1997	2,266	644
1998	774	668

ADFG, 1996, 1997, 1998a

Table 3.21-3 Calendar of Hunting and Trapping in the Delta Region

Species/Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sheep								*	*			
Moose									*			
Bear					*	*	*	*	*	*		
Bison	*	*	*						*	*	*	*
Snowshoe Hare	*	*	*					*	*	*	*	*
Ptarmigan/Grouse	*	*	*	*				*	*	*	*	*
Ducks/Geese									*	*	*	*
Caribou									*			
Furbearers	*	*	*								*	*

Darbyshire & Associates (1980), Ridder (2002)

Table 3.21-4 Big Game Hunting Effort in the Shaw Creek and Goodpaster Drainages

Species[1]	/ Drainage	1998	1999	2000	2001
Moose	Shaw Creek	81	71	91	98
	Goodpaster	117	111	121	134
Caribou	Shaw Creek	1	0	0	N/A
	Goodpaster	5	1	11	N/A
Sheep	Shaw Creek	0	0	0	0
	Goodpaster	1	2	2	1
Black Bear	Shaw Creek	0	1	4	N/A
	Goodpaster	1	3	2	N/A
Brown Bear	Shaw Creek	0	1	1	N/A
	Goodpaster	0	1	1	N/A

[1] Only successful hunters noted for black and brown bear

Similar to other locations within the project area, the Goodpaster River Valley also is noted for both recreational and commercial trapping, including the harvesting of lynx, marten, beaver, muskrat, snowshoe hare, and wolf (Korvola, 2000a).

In addition, a well-developed winter trail system along the Goodpaster River is used by a variety of recreational modes, including snow machines, dog teams, and skiers in the winter and spring months (Teck-Pogo Inc., 2000d). Although people use the winter trail for day trips (20 percent), its main use is for overnight trips by fishers and residents accessing their cabins on the Goodpaster River (80 percent). During most years, the trail is used once or twice for organized events such as races or trail rides. It is also used up to three times per day by up to four different dog mushing teams (Korvola, 2000a).

Shaw Creek Valley

Moose hunting effort in the project area primarily occurs along the Richardson Highway, the Trans-Alaska Pipeline work pad, and the trails in lower Shaw Creek Flats. Trappers also are active in the Shaw Creek Valley (Korvola, 2000a). The mouth of Shaw Creek, along the edge of the flats, is also an important grayling fishery, especially in the spring. In recent years, recreational airboat activity also has increased in the Shaw Creek Flats.

The Shaw Creek Flats area also supports the Indian Creek Trail, connecting the Richardson Highway, Quartz Lake, and the Goodpaster River, primarily for winter recreational uses. In addition, there are eight private recreational parcels in the lower Shaw Creek Flats. These parcels are accessed by airboat, ATV, and snow machine (Korvola, 2000a).

Quartz Lake

The Quartz Lake Recreation Area and vicinity are popular destinations for both summer and winter recreational activities. Summer recreational activities on and around Quartz Lake include fishing, boating, hiking, swimming, and ATV riding. The lake itself is the most popular fishing destination in the Tanana Valley because of road access and ADFG stocking efforts. Quartz Lake supports both a winter ice fishery and an open-water fishery. Quartz Lake also supports casual trapping activities (Korvola, 2000a; Ridder, 2002).

Estimates of effort, harvest, and catch in the Quartz Lake fishery have been obtained annually since 1983 through statewide harvest surveys. From 1996 to 1998, the average annual effort was 9,095 angler-days, with an average annual harvest of 5,437 coho salmon, 650 Arctic char, and 11,799 rainbow trout (Table 3.21-5).

Table 3.21-5 Quartz Lake Sport Fish Effort and Harvest, 1996 to 1998

Year	Angler Days	Coho Salmon	Arctic Char	Rainbow Trout
1996	10,155	7,785	436	12,565
1997	6,956	2,999	313	8,496
1998	10,175	5,526	1,201	14,335
Average	9,095	5,437	650	11,799

ADFG, 1996, 1997, 1998a

Volkmar Lake

There are 38 private recreational parcels in the vicinity of Volkmar Lake. The lake is accessed by airboat, airplane, and snow machine. Volkmar Lake offers good fishing for Northern pike both summer and winter. In addition, moose hunting occurs around Volkmar Lake (Korvola, 2000a, Ridder, 2002).

Healy Lake

Healy Lake offers both summer and winter fishing. There are 19 private recreational parcels in the vicinity of Healy Lake in addition to the village of Healy Lake. The lake is accessed by riverboat, airboat, airplane, and snow machine. An ice road provides access in the winter months. Moose and waterfowl hunting is popular around Healy Lake (Korvola, 2000a, Ridder, 2002).

Tanana River

The Tanana River offers salmon, grayling, whitefish, northern pike, and burbot fishing (ADFG, 1996, 1997, and 1998a). Riverboats, canoes, rafts, and kayaks also are used by residents and visitors on many rivers in the project region, including the Tanana, between mid-April and October. Waterfowl and moose hunting are popular along the Tanana River (Korvola, 2000a, Ridder, 2002).

Other Recreational Areas and Activities

Other dispersed recreational activities in the project area include hiking and gardening in summer, berry picking toward fall, wood gathering year-round, and winter sports such as dog mushing, skiing, and snow machining (Table 3.21-6). Locally available berries include blueberries, raspberries, strawberries, bearberries, crowberries, high- and low-bush cranberries, and currents. Numerous well-developed trails in, around, and through the region are used by an estimated 200 snow machines and 5 to 15 dog teams (Ridder, 2002).

3.21.2 Recreation Opportunity Spectrum

Recreation Opportunity Spectrum (ROS) is used by many land management agencies, including the U.S. Forest Service and Bureau of Land Management, to describe and identify recreational settings. ROS describes the mixes or combinations of settings, remoteness, access, activities, and probability of recreation opportunities along a spectrum that is divided into six classes: primitive, semi-primitive nonmotorized, semi-primitive motorized, roaded natural, rural, and urban. The ROS represent a range of recreational experiences from a high probability of self-reliance, solitude, challenge, and risk to social experiences with a high degree of interaction with other people (U.S. Forest Service [USFS], 1998).

Table 3.21-6 Calendar of Selected Recreational Activities in the Delta Region

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Berry Picking							*	*	*			
Hiking and Gardening					*	*	*	*	*			
Wood Gathering	*	*	*	*	*	*	*	*	*	*	*	*
Dog Mushing	*	*	*							*	*	*
Skiing	*	*	*							*	*	*
Snow Machining	*	*	*							*	*	*

Darbyshire & Associates (1980), Ridder (2002)

Four ROS classes were inventoried in the project area: primitive, semi-primitive motorized, roaded natural, and rural. The inventoried ROS classes within the project area are illustrated in Figure 3.17-5.

- **Primitive** These areas are present throughout the project area, especially in the higher elevations. Primitive areas are characterized by essentially unmodified natural environment of fairly large size. Many of these areas, including the upper reaches of the Goodpaster River and the higher elevations of the surrounding ridges, include very few, if any, modifications to the natural setting. Interactions between users are very low and evidence of other users is minimal. Motorized use of these areas is extremely limited and primarily restricted to backcountry airstrip access, if available. Evidence of surface or vegetative disturbance is limited and there is little evidence of primitive roads, motorized use or human users.
- **Semi-Primitive Motorized** These areas include trails and water bodies in the project area, such as the lower Goodpaster River and Goodpaster Winter Trail, Indian Creek Trail, Shaw Creek Flats, and Volkmar Lake. These areas have subtle modifications to the natural setting, such as primitive roads/trails, motorized use areas, and small isolated structures, such as cabins found along the Goodpaster River downstream from Central Creek and lower Shaw Creek Flats. Motorized access in semi-primitive areas is almost entirely limited to trails and water bodies (Ridder, 2002).
- **Roaded Natural** These areas include the Richardson Highway from north of Shaw Creek Road to Big Delta, Shaw Creek Road, Quartz Lake, the Richardson Highway south of Delta Junction, and the Alaska Highway southeast of Clearwater Road. The natural setting in these areas includes moderate alteration, where the cultural modifications do not dominate the setting and generally harmonize with the natural landscape. Roads and highways are present, and structures are scattered, remaining visually subordinate. Frequency of human contact is low to moderate. Over the 12 miles between Shaw Creek Road and Big Delta, the natural setting is only slightly altered, with only two houses, one gravel pit, and one quarry visible (Ridder, 2002).
- **Rural** The Richardson Highway and Alaska Highway corridors from Big Delta to the intersection of Clearwater Road and the Alaska Highway, including Delta Junction, and to Jack Warren and Clearwater roads, were inventoried as rural. The natural setting between the Tanana River Bridge at Big Delta, and Delta Junction, is substantially altered with cultural modifications, i.e., service facilities and infrastructure are constantly in sight. Roads and highways are obviously present and structures readily apparent. Frequency of human contact is moderate to high in these areas. Additionally, from Big Delta in the west to the Gerstle River in the east, the area north of the highways to the Tanana River (excluding north of the Clearwater River) is substantially altered with very visible farmlands and houses (Ridder, 2002).

3.22 Utilities

The only utility associated with the project area that could supply enough power to meet the needs of the Pogo project is GVEA. GVEA is a nonprofit, member-owned cooperative headquartered in Fairbanks that provides electrical service to the FNSB, the Denali Borough, unincorporated areas between these two boroughs, and along the Richardson Highway to Fort Greely. Clear Air Force Station, Eielson Air Force Base, Fort Wainwright, Fort Greely, Fort Knox Gold Mine, the University of Alaska Fairbanks, and the communities of Fairbanks, North Pole, Nenana, Delta Junction, and Healy are all located in GVEA's service area.

GVEA provides electricity to approximately 90,000 people through more than 36,000 service locations, and has a generating capability of 224 MW of power, with an additional 70 MW available through the existing Fairbanks-Anchorage Intertie (U.S. Department of Interior [USDI], 1998). In 1997 GVEA peak demand was 163 MW (GVEA, 1998). The project area is served by an existing power line that parallels the Richardson Highway from Fairbanks to Delta Junction.

In anticipation of projected growth in its service area, GVEA has proposed a modification to its North Pole power plant that would provide an additional 60 MW of continuous power and 120 MW of peak power. The proposed GVEA project is presently in the air permitting process, with the first phase of the project projected to be on-line by the end of 2004.

Chapter 4 Environmental Consequences

This chapter describes the environmental impacts of project development for each alternative, determines the severity of those impacts on the human environment, and discusses whether those impacts could be mitigated.

The format used in this chapter to present the impacts for each resource is the same:

1. Impacts that would occur if no action were taken are described (Alternative 1)
2. Impacts for each of the three action alternatives (Alternatives 2, 3, and 4) are described
3. Cumulative impacts are discussed

How each of these steps was approached is described below.

No Action Alternative

To standardize the process for determining impacts of the No Action Alternative on each resource, specific assumptions were made. These assumptions are shown in Table 4.0-1.

Table 4.0-1 No Action Alternative Assumptions

1. Socioeconomics

- No prison constructed at Fort Greely
- Construction of a National Missile Defence System (NMDS) at Fort Greely beginning in 2002, with completion by approximately 2004 (3 years).
- NMDS construction employment would average 400 jobs. Most of the construction labor force would be nonresidents and would be housed on site. The total NMDS-related population during operation (including employees, their dependents, and indirect population increase) would be approximately 350 residents.
- Natural gas pipeline construction between 2005 and 2008. Impacts on the Delta area would occur for 2 years during this period, with peak impact lasting for approximately 9 months. The large majority of workers would be nonresidents of the Delta area. There would be almost no increase in population from actual gas pipeline operation.
- Once the NMDS is constructed, the Delta area population should stabilize at approximately 2,100 residents, below the pre-base closure peak of 2,388 residents in 1993.

2. Non-Resource Development

Residential land sales

- Some additional private residential land would be needed for a portion of NMDS workers. There would be no sales of state land in the project area. Natural gas pipeline construction would not increase residential land needs.
- State land sales would adhere to the TBAP.

Agricultural land sales

- New agriculture land sales in the Delta area unlikely in the near future, unless there are substantial changes in operation expenses and the market and demand for farm-related products.

Commercial and Industrial Activities

- Existing, and possibly new, commercial and industrial activities (such as lodges, stores, and rock quarries) would occur in the existing developed Delta area at a pace consistent with ongoing needs or other actions in the area.

Table 4.0-1 No Action Alternative Assumptions

Power

- GVEA's Fairbanks to Delta power line would be upgraded for NMDS. This upgrade would not require more or higher poles, nor more clearing of the ROW.

3. Resource Development

Timber

- The current TVSF 5-year schedule for timber sales (FY 2003 to 2007) would be implemented, given existing winter trail access routes and market demand. The current 5-year schedule proposes harvesting four timber sales on the northwest side of lower Shaw Creek. See Section 3.17.1 for greater detail.
- The DOF would construct its planned all-season road to access timber along the Shaw Creek Hillside to harvest three of those sales totalling approximately 433 acres. This road likely would be constructed incrementally over the next several years, depending on sale of the proposed harvest units and additional capital funding. The road would be open to the public. Its route would be very similar to the Shaw Creek Hillside all-season road route proposed by the Applicant and would extend to Gilles Creek. Estimated *total* round trips on this road by logging trucks, for each of the three *entire* sales, are 142 (Fowler Creek), 285 (Keystone Bluff # 1), and 485 (Keystone Bluff # 2). These trips would average between approximately 2 and 3 truck round trips per day.
- The DOF eventually would construct its planned all-season road around Quartz Lake to access timber in the vicinity of Quartz Lake and Indian Creek near the South Ridge route for the all-season road option. It would be open to the public. Like the proposed Shaw Creek Hillside forestry road, it likely would be constructed incrementally and would be dependent on additional capital funding or timber sale activity. The current 5-year schedule for timber sales proposes four timber sales in the Quartz Lake and Indian Creek area, totalling approximately 610 acres. Of that total, two sales totalling approximately 470 acres would be accessed from the proposed new DOF road, while one sale of approximately 80 acres northeast of Quartz Lake would be accessed from the existing winter road on Shaw Creek Flats. Estimated total round trips on the DOF road by logging trucks, for each of the two entire sales using the road, are 266 (Quartz Lake # 1) and 950 (Indian Creek # 1). These trips would average between approximately 2 and 3 truck round trips per day.

Mining

- Mineral exploration likely would slow or perhaps decline from current levels either because a lack of Pogo permits would cool mining companies' interest in the area or because the Applicant decided not to proceed on economic grounds (e.g., low price of gold).

Recreation

- Slow increase in use of the Goodpaster River Valley.

Alternatives

Section 2.5 (Action Alternatives Identification) discussed how the options were grouped into three categories; those options that were common to all alternatives (Table 2.5-1); those that differed between alternatives but were not related to surface access (Table 2.5-2); and finally, those that differed between alternatives and were related to surface access (Table 2.5-3). Figure 4.0-1 graphically presents all the options that differ between the action alternatives. Those on the left side of the figure are not related to surface access, while those on the right side of the figure are related to surface access. This figure can be used to track the discussions of individual resource section impacts in this chapter.

Note that Figure 4.0-1 does not contain those options that would be common to all alternatives (Table 2.5-1) because, by definition, there would be no difference in impacts between the alternatives. These common option impacts, however, are discussed in each individual resource section. As a convention, if a particular option would have no or only a low impact on a given resource, that option generally was not discussed.

ALTERNATIVES ANALYZED IN THIS EIS

AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1]	COMPONENTS NOT SURFACE ACCESS RELATED		WATER DISCHARGE		COMPONENTS SURFACE ACCESS RELATED: ACCESS				
	TAILINGS FACILITY LINER	POWER SUPPLY	DEVELOPMENT PHASE	OPERATIONS PHASE	TYPE	ROUTE	USE	DISPOSITION	POWER LINE ROUTE
	Options	Options	Options	Options	Options	Options	Options	Options	Options
ALTERNATIVE 1 **NO ACTION**	Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented.								
ALTERNATIVE 2 Applicant's Proposed Project	Unlined	Power Line	Injection Wells	▪ Injection Wells, and ▪ SAS ◆ At airstrip ◆ Above Pogo Ridge	All-Season Road	▪ Shaw Creek Hillside, Richardson Egress ◆ Shaw Creek Road ◆ Tenderfoot	▪ Pogo Project Only, or ▪ Pogo and: ◆ Industrial/ Commercial ◆ Everyone	▪ Remove/Reclaim, or ▪ Road Left Open to: ◆ Industrial/ Commercial ◆ Everyone	Shaw Creek Hillside
ALTERNATIVE 3 South Ridge Route Direct Discharge	Lined	"	Direct Discharge to Goodpaster River	Direct Discharge to Goodpaster River	"	South Ridge	"	"	South Ridge
ALTERNATIVE 4 Winter Only Access Off-River Treatment Works	"	On-Site Generation	Off-River Treatment Works	Off-River Treatment Works	Winter Access Only ▪ Traditional Road ▪ Perennial Trail	Shaw Creek Flats	N/A[2]	N/A	N/A
Major Options Eliminated From Further Consideration[3]			Constructed Wetlands		Railroad Air Only (5,000-ft Airstrip)	Richardson Egress: ▪ Pipeline ▪ Keystone Dean Cummings Crossing Goodpaster Valley		Convert to Recreational Trail	

[1] Excludes those components/options common to all alternatives (Table 2.5-1).
[2] Not applicable to this alternative.
[3] See Appendix A.1.

Figure 4.0-1

Cumulative Impacts

Cumulative impacts are defined as follows (40 CFR 1508.7):

> Cumulative impacts result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative impacts can result from individually minor impacts that, when viewed collectively over space or time, can produce significant impacts.

To standardize the process for determining cumulative impacts for each resource, specific scenarios were developed. These scenarios are presented in Table 4.0-2. For example, if the Pogo project were developed with an all-season road it is reasonable to assume that planned timber harvests would accelerate within the state forest through which it would pass. It is also reasonably foreseeable that another mine could be developed because of the increased access. Thus, the cumulative impact discussions consider accelerated timber harvests in the state forest, an extended Pogo Mine life because of discovery of additional reserves, development of a hypothetical Sonora Creek mine 8 miles from the Pogo ore body, and development of another hypothetical Slate Creek mine approximately 32 miles northeast of the proposed Pogo Mine site and accessed by extension of an all-season road.

When considering the projected cumulative impacts from the hypothetical mine scenarios, however, it should be noted that in Alaska it typically has taken from 10 to 15 years to bring a mine into production from the time a deposit is discovered. Because no other deposits have been discovered in the Pogo area yet, the likelihood of another mine coming into production during the life of the Pogo Mine project is low.

Note that for all three action alternatives, it was assumed that at the time of Pogo Mine closure the mine site would be accessible by an all-season road. The presence of the road was assumed either because Alternative 2 or 3 would be implemented or, if Alternative 4 were implemented, the planned DOF Shaw Creek Hillside road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and effectively be operated like a complete all-season road. This assumption, therefore, provided a “worst-case” impact scenario. Thus, because all three alternatives would effectively provide all-season road access to the Pogo Mine site, cumulative impacts were determined largely by whether the all-season access road would be removed and reclaimed at the time of proposed Pogo Mine closure or would be maintained for extended Pogo Mine life, other resource development purposes, and public use.

Section 4.19 (Cumulative Impacts), near the end of this chapter, summarizes the cumulative impacts described for each resource below in both tabular format and a comparative discussion.

Table 4.0-2 Cumulative Impact Assumptions

1. Socioeconomics

- Pogo Mine development would not change the No Action Alternative scenario.
- Development of the Pogo Mine would occur early in the construction boom driven by the NMDS and gas pipeline.
- Mine construction would not measurably affect the Delta area population because construction jobs would be temporary, camp-supported, and filled primarily by nonlocal workers.

Table 4.0-2 Cumulative Impact Assumptions

- Between 100 and 135 of the mine's 385 employees would live in the Delta area with the all-season road option once the mine were in full production. Including dependents and indirect population effects, this option would result in between 260 and 350 mine-related Delta area residents.
- By the end of the decade (or once the NMDS and gas pipeline were constructed), development of the Pogo Mine with the all-season road option would result in a Delta area population of between 2,300 and 2,400, of which between 11 to 15 percent would be mine-related.

2. Non-Resource Development

Residential land sales

- Development of private lands in the Shaw Creek, Tenderfoot, Richardson, and Quartz Lake areas for homes and possibly businesses would be accelerated. Some new roads and GVEA ROWs would be needed to access residential land .

Agricultural land sales

- New agriculture land sales in the Delta area would be unlikely in the near future, unless there are substantial changes in operation expenses and the market and demand for farm-related products.

Commercial and industrial activities

- Commercial and industrial activities in the already developed Delta area would likely increase directly related to the scale and requirements of the project. This increase could include activities such as additional fuel, food, other service, or public facility-related development.

Power

- GVEA power line upgrade for NMDS also would be adequate for the Pogo project. If Pogo were constructed first, then the same upgrade would occur and be adequate for the NMDS.

3. Resource Development

Timber

- The Pogo access road would be available for timber harvesting from state lands, and DOF would not construct its own timber access road. The annually updated TVSF 5-year timber sale plan would incorporate an acceleration in timber sales and volume because of the road.

Mining

- An all-season road would increase access for mineral exploration and development in the Shaw Creek and Goodpaster River drainages, and possibly in adjacent drainages such as the Salcha River. New mineral developments might extend either access option farther than required just for the Pogo project. If new developments occurred, associated airstrips would be constructed.
- **For purposes of this analysis, three mine scenarios were considered.**

  Extended life of the Pogo Mine because of discovery of additional reserves. These reserves could be accessed underground from the existing tunnel network, or by one or more additional adits in the general vicinity of the present ore body. Minimal additional surface facilities would be developed (~20 acres of disturbance). Ore would be trucked or otherwise conveyed to the existing mill for processing. This extended mine life could cause a change in the number and type of traffic over time on the project access road.

  Sonora Creek mine (hypothetical) – Another ore deposit would be developed by the Applicant within the Pogo claim block at the head of Sonora Creek, approximately 8 road miles southeast of the Pogo ore body (Figure 3.17-4). Sonora Creek mine would be an underground mine. This scenario assumes an all-season road extended to this site (~75 acres of disturbance) with ore hauled by truck to the Pogo mill and tailings deposited in the proposed Pogo dry stack at the head of Liese Creek. Construction of minimal surface facilities is assumed at the site (~50 acres of disturbance), with the proposed Pogo facilities (such as mill, camp, and airstrip) used in its support.

  Slate Creek mine (hypothetical) – A deposit would be developed by another company on Slate Creek near the headwaters of the Goodpaster some 32 road miles northeast of the Pogo Mine site (Figure 3.17-4). This scenario assumes a complete stand-alone project with facilities that would include a mill, tailings disposal site, camp, and 3,000-ft airstrip (~240 acres of disturbance). It is assumed that ground access would be by extension of an all-season road from the existing airstrip at the proposed Pogo Mine site (~220 acres of disturbance).

Table 4.0-2 Cumulative Impact Assumptions

Recreation
Recreational access and activities along the all-season road corridor would increase. Easier access for motorized off-road vehicles (ATVs and snow machines) would enable them to travel well into the backcountry. A Division of Parks way-side would be developed at the Goodpaster River crossing.
4. Access
At time of Pogo Mine closure, the mine site would be accessible by an all-season road, either because Alternative 2 or 3 were implemented or, if Alternative 4 were implemented, because the planned DOF road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and be effectively operated like the complete all-season road. It was assumed that an all-season road would be open to public use.

4.1 Surface Water Hydrology

This section presents a discussion of the surface water hydrology. Surface water quality is discussed in Section 4.3.

4.1.1 No Action Alternative

Closure of existing mine area facilities currently operating under a 5-year underground exploration permit would result in cessation of water treatment plant discharge of treated mine inflow waters of between 50 and 150 gpm (Teck-Pogo Inc., 2002b, 2002f). Currently, this discharge is to the Goodpaster Valley alluvium through injection wells. This water ultimately discharges to the Goodpaster River (Teck-Pogo Inc., 2002h). The adit would be plugged, and collection of mine inflow waters would not be necessary for the No Action Alternative. Plugging of the adit and cessation of these flows is expected to result in no measurable or substantial changes in stream flow under this alternative.

The surface water hydrology of the Shaw Creek watershed without the construction of the Shaw Creek access route would be unaffected. DOF timber sales would result in road construction and timber harvesting that could cause some small changes in the hydrologic response of the Shaw Creek watershed to precipitation and snowmelt. These impacts would be low.

In areas near Shaw Creek Road, Quartz Lake, and along the Richardson Highway, additional development of private roads, residential construction, and commercial construction could result in substantial increases in stormwater runoff volumes and rates on a local basis. This development could occur in response to construction of the NMDS system.

Overall, the impacts on project area surface water from the No Action Alternative would be minimal.

4.1.2 Options Common to All Alternatives

Underground Mine

Some uncertainty exists with respect to the possible connection of Liese Creek with the underground mine workings through the Liese Creek fault zone. Large quantities of water (up to the entire flow of Liese Creek) could flow through fault zone fractures to the underground workings, although this is not expected. If it were to occur, it would reduce the flow in the reach of Liese Creek below the mine and would reduce the flow into the wetlands located between Liese Creek and the Goodpaster River. If a substantial portion of the Liese Creek flow were to enter the mine through the fault, the quantity of water pumped from the underground workings would increase dramatically and be discharged to surface or subsurface waters after treatment. Such high flows into the mine through the Liese Creek fault zone would be mitigated by contingency plans (Teck-Pogo Inc., 2002b). A description of these plans may be found in the underground mine discussion in Section 4.2.2 below. If high inflows to the mine were caused by connection through the fault zone, Liese Creek would be diverted or contained within a conveyance so that losses to the underground workings would be minimized. Therefore, implementation of the contingency plans would likely result in small hydrologic effects to Liese Creek downstream of the mine.

Tailings Disposal

- Underground Seepage from the tailings paste disposal underground is expected to be a minor flow of approximately 2 gpm (Teck-Pogo Inc., 2002h) and is not anticipated to affect the surface water hydrologic regime of Liese Creek or the Goodpaster River.

- Surface Dry Stack and RTP The surface water hydrologic regime of Liese Creek would experience substantial changes from the tailings and mineralized development rock placed in the upper reaches of the watershed and construction and operation of the RTP. These changes would occur because of:

- Diversion/retention of runoff waters
- Stormwater release from the RTP
- Seepage flows from the RTP
- Seepage flows from the dry-stack tailings
- Runoff and seepage following closure

The total annual watershed yield would be reduced by perimeter and toe ditches that would capture runoff in and near the dry stack and the RTP. In addition, runoff losses would be caused by seepage through the diversion ditch system surrounding the dry stack and RTP. Runoff water captured within the dry stack and RTP facilities would be recycled through the mill and reduce the quantity of makeup water required.

These changes in surface hydrology would be substantial modifications within the context of the Liese Creek Valley, but would be very small within the context of the overall hydrology of the Goodpaster River.

The RTP is designed to contain more than the maximum water storage volume during normal operating conditions, plus the runoff volume from the 100-year, 24-hour precipitation event. Based on deterministic computations, the estimated pond volume required is 30 million gallons. Use of a probabilistic method resulted in a more conservative 40-million-gallon design capacity, which is what the proposed designed is based on. Large-magnitude storms, however, may result in a release of RTP water through the emergency spillway into Liese Creek. The Applicant has predicted through modeling that the probability of this occurring is 22 times in 1,000 years (approximately 1 in 45 years). Given an 11-year projected project life, there is approximately a one in four chance that a storm discharge would occur from the RTP to Liese Creek during the life of the mine. The hydrologic effects on Liese Creek from this degree of storm discharge are likely to be masked by the effects of storm runoff from the watershed in general. The expected effect of such an event would be a reduction in the peak flow of Liese Creek due to routing water through the ditch and pond system, and a reduction in the total discharge because of water retention within the RTP surge capacity (Teck-Pogo Inc., 2002b).

Mill and Camp

There would be changes to runoff volumes and rates due to capture and treatment of runoff from the mill and camp areas within the Liese Creek watershed. Runoff upgradient from the mill and camp would be captured in a diversion ditch and routed as noncontact water to Liese Creek. Runoff water from the mill and camp area would be captured and stored in the RTP for reuse. The effect of the capture on runoff from the mill and camp area is expected to result in a minor reduction in the flow of Liese Creek. These changes in hydrology to Liese Creek would cause minimal impacts to the overall hydrology of the Goodpaster River.

Gravel Source

The gravel pits adjacent to the airstrip would be constructed approximately 200 ft southeast of the normal active channel of the Goodpaster River. Under extreme flood conditions, the gravel pits could become inundated. The magnitude of such a flood event, however, would be severe enough to result in natural widespread flood effects to the valley beyond simple inundation of the gravel pits. Therefore, the gravel pits would not alter the surface water hydrology of the Goodpaster River.

Construction Camp

Potential impacts to surface water hydrology from this camp would be restricted to surface runoff from storm events and snowmelt. There is an existing stormwater management system at the camp that would serve to capture stormwater from the site during the construction phase. This area would generate additional runoff in comparison to natural conditions; however, routing through the stormwater pond and the relatively small area involved would result in no measurable effect on the surface water hydrologic regime of the Goodpaster River.

Laydown Areas

The laydown areas are not anticipated to affect the surface water hydrologic regime of the Goodpaster River. Vegetation removal and soil compaction may cause an incremental increase in runoff volume and rate; however, this increase would not likely be measurable within the Goodpaster River.

Water Supply

Industrial The make-up water supply wells are located within the alluvium of the Goodpaster River and are therefore in communication with the Goodpaster surface flows. The use of these wells would be limited to periods when all other water sources could not provide sufficient water. This well use is expected to be intermittent and infrequent. Under drought conditions, make-up water from water supply wells may be necessary. When wells are needed, demand is expected to be up to 100 to 200 gpm (Hanneman, 2002d). Under such conditions, it is assumed the Goodpaster River would also be experiencing drought flows. Intermittent withdrawal of water from the water supply wells could impinge on in-stream flows to a minor degree, but is not expected to have a substantial effect on the stream flows of the Goodpaster River. Should extremely low Goodpaster River flow conditions develop, the mine could use bedrock water sources (e.g., wells above the dry-stack pile in upper Liese Creek) if sufficient reserves were available, thus mitigating potential effects on the low-flow conditions of the Goodpaster River.

Domestic An average of 100 gpd for each of the 250 camp residents would be required for a total of 25,000 gpd. The average pumping rate to produce this quantity of water is 17 gpm (Teck-Pogo Inc., 2002b, 2002f). Although instantaneous pumping rates may be higher, the pumping would be intermittent, allowing time for drawdown to recover. Tests conducted on injection wells in this same material suggest a very high hydraulic conductivity capable of accepting or supplying water far in excess of an average 17-gpm rate. Domestic water wells are not expected to affect Goodpaster River surface water hydrology.

Water Discharge

- **Domestic** There would be a single domestic wastewater treatment system for disposal of domestic wastewater. It would be located at the construction camp below the 1525 Portal in the Goodpaster River Valley and would treat camp domestic wastewater for discharge to the Goodpaster River at a location 0.2 mile downstream from the exploration camp as shown in Figure 2.3-1a. Operation of the system is not expected to result in a measurable change in flow rate to surface waters.

Air Access

Construction and use of an airstrip in the Goodpaster Valley is anticipated to have no measurable surface water hydrologic consequences for the Goodpaster River. The potential influence of this facility on surface water hydrology may be a minor increase in the runoff volume and rate because of vegetation removal and soil compaction and is unrelated to the intensity of facility use. Implementation of stormwater BMPs for the airstrip would attenuate any such effects. The incremental increase in runoff volume and rate, if any, would not likely be measurable within the Goodpaster River.

Vessel Navigation

The proposed Goodpaster River Bridge would not affect present or reasonably foreseeable vessel use of the Goodpaster River. From the recreational fleet perspective, there would be no effects either because of navigational impediments or public overland access. The bridge clearance would be 11.2 feet at normal high water, with 65 feet between piers, to allow safe passage of recreational airboats that might occasionally navigate the river. The mine access road leading to the bridge would be closed to public use during the life of the proposed project, and ADNR's ROW authorization would require the Applicant to remove and reclaim that segment of the road following mine closure.

There would be sufficient distance between the bridge and the upstream and downstream bends to allow proper vessel alignment for safe passage of vessels through the proposed bridge. The vessels that infrequently navigate the Goodpaster River are small and highly maneuverable, allowing them to safely and efficiently pass the proposed bridge. There are no other factors located within one-half mile of the proposed bridge that would create hazardous passage through the proposed structure.

It is unlikely that government agencies would respond by watercraft to an emergency in the vicinity of the proposed bridge, because the proposed location is 68 river miles from the mouth of the river and, due to the shallow nature of the river, it is not always navigable to typical riverboats. Emergencies on the Goodpaster River at or above the proposed bridge location would be responded to by a helicopter flight from one of the local helicopter service companies (Nay, 2003).

There are no alternate routes for vessels to bypass the proposed bridge location, but the proposed bridge would not prohibit entry of any vessels to a harbor of refuge.

Local hydraulic and atmospheric conditions would not increase the hazard of passage through the proposed bridge. Vessels that might occasionally encounter fog, an infrequent occurrence in this subalpine environment, would have to slow down to navigate through the bridge structure, but would be able to pass safely.

4.1.3 Options Not Related to Surface Access

Alternative 2

Tailing Facility Liner

The unlined dry-stack and RTP facilities are not anticipated to affect the surface water hydrologic regime of Liese Creek or the Goodpaster River. Seepage from the dry stack that might otherwise be expressed as surface water flow would be captured within the RTP. In turn, seepage from the RTP would be captured within a seepage control system at the toe of the dam and recycled to the pond.

Water Discharge

- Soil Absorption System
  - Adjacent to airstrip Discharge of excess treated water through an SAS in the Goodpaster River Valley was not anticipated to cause any measurable impact to the hydrologic flow regime for surface water of the Goodpaster. Continuous injection into this facility could result in a minor, but probably not measurable, increase in the flow of the Goodpaster River.
  - Saddle above Pogo Ridge The SAS could be optionally placed in the saddle above and southeast of Pogo Ridge at the top of either the Liese Creek or Easy Creek valley. If the SAS were located in Liese Creek Valley, there would be the potential that subsurface flows containing water discharged from the SAS could ultimately be collected by the RTP, which would result in a water balance problem. Thus, this discussion assumes that the SAS would be in Easy Creek Valley. The design of the system would be essentially the same as was described in Section 2.3.10, except that an approximately 2-mile pipeline would be required to transport water from the high-density sludge (HDS) coprecipitation treatment plant. If the

discharge from the SAS surfaced in the Easy Creek Valley, it would add to the flows in Easy Creek. The extent to which the discharge would surface is uncertain.

- Underground Injection Wells Discharge of treated water through underground well injection into the Goodpaster River alluvium was not anticipated to cause any measurable change to the surface water hydrologic regime.

  Tests conducted on the existing injection well show that a water level rise of up to 2 ft could occur within the alluvium. Tests conducted on the existing injection well, and groundwater flow modeling, show that a water level rise of up to 2.9 ft could occur within the alluvium at the maximum injection rate of 400 gpm (Davies, 2002b). Under most circumstances, and at distances of 100 ft or more from the injection wells, water level rises of 2 ft or less should be expected.

  The alluvium contains relic scour holes and residual channels that are now sloughs filled with alluvial ground water. An increase in the water level of the alluvium could raise the level of the sloughs. Should this occur, flow between sloughs may be established, but probably at a very low rate and very local to the injection well. The alluvium is in direct hydraulic communication with the surface water of the Goodpaster River. Continuous injection may result in a minor, but probably not measurable, increase in the flow of the Goodpaster River either through the alluvial contribution or the sloughs.

Alternative 3

Tailing Facility Liner

Lined dry-stack and RTP facilities are not anticipated to affect the surface water hydrologic regime of the Goodpaster River or Liese Creek. Seepage from the dry stack that might otherwise be expressed as surface water flow would be captured by a liner system and routed to the RTP. Seepage from the RTP would be contained by a liner within the RTP. With or without a liner, seepage from the RTP would be captured within a seepage control system at the toe of the dam and recycled to the pond, thereby preventing surface or subsurface discharge.

Water Discharge

- Direct Discharge to Goodpaster Treatment and direct discharge to the Goodpaster River would increase the base flow of the river by the discharge amount. The normal operational discharge during the operational phase is expected to be between 200 gpm (0.44 cfs) and 400 gpm (0.9 cfs), with a projected peak of 750 gpm (1.7 cfs). The Goodpaster River exceeds an average discharge of 100 cfs between April and October, with peak seasonal discharge exceeding 7,500 cfs. The minimum seasonal flow is approximately 40 cfs, and the 100-year low flow is approximately 10 cfs (Teck-Pogo Inc., 2002d). As a percentage, the maximum direct discharge (1.7 cfs) would comprise 1.7 percent of the average Goodpaster flow of 100 cfs, 0.02 percent of the peak seasonal discharge of 7,500 cfs, 4.25 percent of the minimal seasonal flow of 40 cfs, and 17.0 percent of the 100-year low flow of 10 cfs. Under all of these discharge conditions, except the 100-year low flow, the contribution to flow in the Goodpaster would not be substantial and it is unlikely that the maximum discharge would occur during Goodpaster River low flows, because high discharge rates are expected to only occur when surface runoff is at a maximum. Because of proposed management practices, however, water would not be discharged when a ratio of total river flow to discharge flow of 45 to 1 could not be met. Hence, as discussed above, actual increases would be expected to be limited to an approximately 2 percent increase in river flow, which would not be measurable.

The discharge during the development phase is expected to be a maximum of approximately 400 gpm (0.9 cfs). This value would be below discharges for the operations phase discussed above, and would represent correspondingly lower percentages of Goodpaster River flow.

Alternative 4

Water Discharge

- Off-River Treatment Works The off-river treatment works would divert water from the Goodpaster River through an intake channel to off-river ponds. After mixing with treated wastewater, the blended water stream would be discharged to a channel and re-enter the Goodpaster approximately 1,800 ft downstream of the intake channel (Figure 2.4-2). Impacts of this alternative downstream of the re-entry channel would be the same as for the direct discharge option in Alternative 3. Within the approximately 1,800-ft stretch of the Goodpaster River between the intake of the treatment works and re-entry channels, there would be a localized decrease of in-stream flow

Using an expected operations phase nominal treated wastewater discharge of 200 gpm (0.44 cfs) and a design mixing ratio of 25 to 1, the treatment works would require diversion of approximately 11.2 cfs (5,026 gpm) of river water. At the maximum expected treated wastewater discharge of 600 gpm (1.3 cfs), approximately 32.5 cfs (14,586 gpm) of river water would be required. During normal year nonwinter months, it is expected there would be ample river water available for mixing for even the maximum treated wastewater discharge rate.

The typical annual winter low flow for the Goodpaster River is approximately 40 cfs. No water would be taken from the Goodpaster for mixing in the treatment works unless a minimum of 20 cfs remained in the stretch of the river between the intake of the treatment works and re-entry channels. Thus, during typical winter low-flow conditions, approximately 20 cfs (8,980 gpm) of river water, approximately 50 percent of river flow, would be available for use in the treatment works. A 20 cfs flow would be adequate at a 25-to-1 ratio for mixing with a treated wastewater discharge of approximately 360 gpm, well above the nominal discharge rate of 200 gpm. Additional supplementation of river water would be possible with as much as approximately 2.2 cfs (1,000 gpm) of water from wells just north of the treatment works.

As with Alternative 3, it is unlikely that the maximum discharge would occur during Goodpaster River winter lows flows because high discharge rates are expected to occur when surface runoff is at a maximum, during breakup and after summer storms. Under normal conditions, during this winter low-flow period, the RPT volume would be at its lowest levels.

Because this option would not use river water for mixing when low flows in the Goodpaster River reached 20 cfs, modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2.

This option would not use river water for mixing when flows in the Goodpaster River were less than 20 cfs. This would affect the ability to discharge water and has an impact on the overall system water balance. If water discharges are limited during low flow conditions in the river, there is the potential that a higher volume of water would be carried through the winter in the RTP. This would result in less freeboard in the RTP for breakup flows. This effect is reflected in the Monte Carlo modeling which showed that the RTP would overtop more frequently for this option than for Alternative 2. Modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2. Note that the modeling conducted to determine this frequency of overtopping did not include use of supplemental groundwater from wells for dilution water in the mixing; therefore, this frequency is conservative.

4.1.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- Shaw Creek Hillside all-season road The surface water hydrologic effects of a Shaw Creek Hillside all-season road would be associated with the numerous crossings of streams that are tributary to Shaw Creek, and the bridges over Rosa, Keystone, Caribou, Gilles, and Shaw creeks, and the Goodpaster River.

  During and immediately following road construction (approximately 15 months), there would be substantial earthwork disturbance. This disturbance would result in increased runoff volumes and rates because of vegetation removal and soil compaction. Mitigation would occur through the use of stormwater runoff BMPs through and following the construction period until vegetation were re-established. Once vegetation were re-established, runoff would be mitigated for the remaining life of the road.

  Following construction, the road surface itself would yield additional runoff compared to native terrain; however, the limited disturbance of the linear road feature generally running perpendicular to drainages would minimally increase the quantity of runoff to any single receiving water course. Most of the road is at least 1 mile from Shaw Creek, and no surface water hydrologic impacts would occur directly to the creek.

  Bridge construction and use of adequately sized culverts to pass drainage and streams under the roadway would prevent alteration of the surface water flow regime.

  - Richardson Highway egress Egress at the existing Shaw Creek Road would not cause additional surface water hydrologic effects. The Tenderfoot egress sub-option would result in additional temporary construction disturbance and life-of-roadway runoff as described above for the main roadway. Use of the existing Shaw Creek Road would minimize additional disturbed area runoff to surface water.

Use Use of the all-season road during mine operations would not have any traffic-load-dependent effects on the flow rates and quantities of surface water.

Disposition Removal and reclamation would eliminate all potential surface water effects. Leaving the road for various levels of use would continue the same degree of surface water hydrologic effects, regardless of the type of use. It is not likely that the surface water hydrologic effects would be measurable under any of the use scenarios.

Power Line Route

- Shaw Creek Hillside The nature of power line construction and operation would have even fewer effects than the road.

Alternative 3

Surface Access

Route

- South Ridge all-season road This alternative would have six fewer bridges and fewer other stream crossings than the Shaw Creek Hillside all-season road. Because the roadway would be constructed along the divide between the Shaw Creek and Goodpaster River drainages, the potential for impacts to surface water hydrology, regardless of how minor, might impinge on two watersheds rather than one. A mitigating condition would be that the separation distance to substantial discrete streams from the road appears to be a half mile or more.

Use Same as Alternative 2.

Disposition Same as Alternative 2.

Power Line Route Same as Alternative 2.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter-only access Impacts would be the same as for Alternative 2, except for the Shaw Creek Flats winter-only access segment. This segment would not cause a major change to the hydrologic regime of surface water because it would only be used during winter.

  A potential temporary seasonal impact would be the tendency for ice roads to thaw later than surrounding areas, thus raising potential for blockage or rerouting of runoff flows during breakup. This temporary seasonal impact would be localized and minor in extent. Mitigation measures for these areas would be similar to Alternative 2 and resulting minor localized changes to the hydrologic flow regime of surface water would be inconsequential.

4.1.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on hydrologic flow regimes of surface water.

- All-season Road Maintained Development of timber resources, mining, and public recreational and other use all would have potential impacts on the hydrologic regime of surface water that could be cumulative with the activities of the Pogo Mine project. Extension of the life of the Pogo project, development of hypothetical Sonora Creek and Slate Creek mines, or other resource developments occurring because of continued existence of an all-season road individually would cause surface hydrologic impacts of a similar nature and magnitude to those from the proposed Pogo Mine project. Given the likely physical separation of the developments in different watersheds, the State of Alaska's management and regulatory tools, and the individual small impacts to the surface water hydrologic system, these mines and other resource developments would have low cumulative impacts on hydrologic flow regimes of surface water.

4.2 Ground Water

This section presents a discussion of the groundwater hydrology. Groundwater quality is discussed in Section 4.3.

4.2.1 No Action Alternative

Under the No Action Alternative, the exploration adit would be plugged and drill holes would be grouted. The groundwater level would rise to pre-exploration elevations. After groundwater levels were restored, the residual impacts on the groundwater system would be low.

4.2.2 Options Common to All Alternatives

Underground Mine

Development of the underground ore bodies would initially result in local dewatering of the country rock in the vicinity of the mine. Water would be produced from the mine during development and operations. The L1 ore body is located approximately 500 ft below the water table, which would decline in elevation in a cone-shaped depression around the mine during operations. The flow of ground water in the area would be directed toward the underground openings of the mine, rather than the current flow toward the Goodpaster Valley floor. Also, the mine would directly underlie Liese Creek, which presents the possibility of drainage of Liese creek waters into the mine through the Liese Creek Fault zone. Model simulations (Brown, 2002) indicate that annual average mine inflow rates would vary from approximately 70 gpm to approximately 200 gpm during the life of the mine, with peak monthly average flows expected to be as high as 340 gpm. Life-of-mine average inflows are expected to be approximately 140 gpm.

Modeling results contain some uncertainty regarding the timing and quantification of inflows from Liese Creek, which could result in flows increasing beyond expected rates. Contingency plans have been developed to address any unexpected high flows. The contingency plans include conducting detailed advance hydraulic testing to determine water inflow potential before actual mining. If excessive inflows are discovered, grouting of fractures, avoiding high-flow areas, sealing the bottom of Liese Creek, or rerouting the creek in a sealed channel would be performed to limit inflows. The impacts of underground mine development on the groundwater flows systems in the area would be moderate as a result of the redirection of groundwater flow systems, but would be limited to the near vicinity of the mine. The impacts on groundwater systems in the Goodpaster Valley would be negligible as a result of the much larger ground water and surface water flows in the Goodpaster Valley than in the bedrock flow system.

Tailings Disposal

- Underground The mine operational plan calls for backfilling the mine void space with tailings as mining progresses. These tailings are expected to have low values for hydraulic conductivity of approximately 2.9 ft per year, and post-closure groundwater flow through all mined areas is expected to be approximately 29 gpm. The hydraulic conductivity of the backfill material would be similar in magnitude to the hydraulic conductivity of the country rock and former orebody and is not expected to have a major distorting influence on the groundwater flow field.

A small amount of water contained in the pore spaces of the tailings would eventually drain out of the tailings as they resaturate and the groundwater flow system re-establishes itself.

Following closure, the pre-mining groundwater flow system is expected to re-establish itself. The mined areas would resaturate and ground water would resume its flow systems, receiving recharge from the land surface and discharging to the Goodpaster Valley. Drawdown resulting from mining is expected to recover relatively rapidly after mine closure, with flooding of the mine workings by the Applicant in approximately 2 years (Day, 2002a) and water levels returning to approximately the pre-mining condition approximately 50 years after mine closure (Brown, 2002).

The three adits proposed for access to the mine would all have surface access points below the pre-mining hydrostatic head of the orebody, meaning that ground water would have the potential to leak out of or around the mine adits after the groundwater flow field re-establishes itself. The mine adits would be hydraulically plugged with sufficient grouting in fractures and boreholes performed to reduce seepage through or around the adits to negligible rates.

Following closure and resaturation of the mine, ground water would flow through the backfilled underground tailings and the rock mass downgradient of the mine, ultimately discharging in the Goodpaster Valley. Chemical fate and transport modeling has been conducted to determine the likely water quality impacts on downgradient ground and surface water (Brown, 2001). See Section 4.3.2 for an evaluation of water quality impacts.

- Surface Dry Stack and RTP
  - Seepage from dry stack The surface dry stack is expected to release relatively small amounts of water as the interstitial water emplaced with the tailings drains. Model calculations suggest total outflow of interstitial water from the stack would be approximately 6 gpm shortly after completion of the dry stack and would decrease to approximately 1 gpm 50 years later, primarily due to the very fine-grain compacted tailings with low hydraulic conductivity (Davies, 2000). The low hydraulic conductivity of the tailings and higher summer evapotranspiration rates are expected to result in very little infiltration (and out-seepage) of precipitation or snowmelt (Nethery, 2000; Davies, 2002a).

    Water released from the dry stack is expected to flow through the colluvial deposits and weathered bedrock to the RTP. Following closure and decommissioning of the RTP, most of the water would mix with normal precipitation and shallow groundwater recharge and flow down the Liese Creek Valley. Any water that infiltrates into the bedrock flow system is expected to be a part of the groundwater flow system contributing water to the mined areas, and to represent only minor impacts to groundwater resources in the area between the dry stack and the mine.

The removal of topsoil and placement of 1.5 feet of nonmineralized development rock on the dry-stack facility footprint as an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact the quantity of the seepage from the dry stack that would enter the ground water.

- Seepage from RTP The RTP would be constructed in Liese Creek Valley upstream of the mill, camp, and mine entrances. The dam would be constructed to minimize seepage under and around the dam by placement of liners at the toe of the dam and use of grout injections into fractured bedrock, if deemed necessary during construction. Most of the pond would not have an impermeable liner. This absence of a liner would create the potential for seepages out of the bottom of the RTP. These seepages are expected to be relatively small because of the low permeability of the rocks underlying the RTP. For the seepages that do occur (estimated to be approximately 5 gpm), return wells, which would be constructed downstream of the RTP, are expected to intercept and return approximately 80 percent of infiltrated water to the RTP (Davies, 2001). These wells are expected to be inclined as needed to intercept subvertical fractures in the bedrock system with the potential to convey water.

  Any discharges that escape the return wells are expected to enter the groundwater flow system discharging into the mine, or possibly to resurface farther downstream the Liese Creek valley. The bedrock groundwater flow system in this area has a general downward and downvalley flow direction toward the dewatered mine during operations. This water would then be captured by the mine water treatment system prior to discharge. The estimated flow rate of any seepage losses is expected to be less than 1 gpm. Following closure, the RTP would be decommissioned, and residual ground water that had been recharged through the RTP would enter the mine as it resaturates and would be commingled with the mine ground water.

Gravel Source

Gravel extraction near the 3000-ft airstrip would require excavation below the water table. The pits would have a surface water inlet and an outlet only in conjunction with the off-river treatment works option. For all other water discharge options, there would be no connection with surface water They would also likely receive groundwater inflows from the up-valley side and lose water to the groundwater system on the down-valley side. Overall, the impacts on the groundwater system of the Goodpaster alluvial aquifer are expected to be low.

Water Supply

Industrial Industrial water supply would be provided from two wells tapping the Goodpaster alluvial aquifer. Projected demand is expected to be between 100 gpm and 200 gpm (Hanneman, 2002d). Water production at that rate is expected to have a minor impact on the Goodpaster aquifer or river.

Domestic Domestic water supply would be obtained from the same wells used for industrial supply. The average demand is expected to be 17 gpm (Teck-Pogo Inc., 2002i), which is expected to have a negligible impact on the Goodpaster aquifer or river.

4.2.3 Options Not Related to Surface Access

Alternative 2

Tailings Facility Liner

- ✦ Unlined Dry Stack and RTP Same as discussed in Section 4.2.2.

Water Discharge

Development Phase **Industrial**

- ▶ Underground injection wells The Pogo Mine project is expected to generate treated water that would require discharge during the development, operational, and closure phases of the project. This water would come from mine inflows of ground water and surface runoff from mine facilities. During development, water would be injected into three injection wells located in the Goodpaster Valley. Water has been successfully injected at average rates up to approximately 100 gpm since 2000, and testing and modeling have indicated that rates as high as 400 gpm, which is the expected maximum injection rate, are achievable (Davies, 2002b; AMEC, 2001a).

  Injection of water at high rates would result in increases in the elevation of the water surface and slight expansion of inundated areas of ponds and sloughs in the Goodpaster Valley as the groundwater table rose. During some times of the year, naturally high groundwater levels could coincide with groundwater levels that had been elevated 1 to 2 ft as a result of injection, resulting in surface discharge of injected water through low-elevation swales in the floodplain. The expected impacts of the water injection on the groundwater flow system are low.

Operations Phase **Industrial**

The water management plan provides flexibility to direct water into either the SAS or the injection wells, depending on operational needs, quality of water produced, and permitting requirements. The proposed maximum rate for injection, 400 gpm, could occur intermittently throughout the project.

- ▶ Soil absorption system
  - ✦ Adjacent to airstrip Discharge of ground water to the SAS would result in a local increase in groundwater elevations in the vicinity of the SAS of approximately 1 ft (Lyons and Davies, 2001). It is expected that this increase in groundwater elevation would occur over a limited area and the overall effect of the discharged water on the groundwater flow system would be low.
  - ✦ Saddle above Pogo Ridge The discharge from the SAS would enter the ground water below the SAS and flow in the colluvium and fractured bedrock. A portion of this flow could enter the deeper groundwater system. A portion of this flow could also resurface and enter the surface water system.
- ▶ Underground injection wells The impacts on groundwater elevations of discharging water into an underground injection well during operation would be the same as was described for the development phase.

Alternative 3

Tailings Facility Liner

- Lined dry stack A liner system placed under the dry-stack facility would theoretically collect all seepage from the stack for treatment (if needed) and discharge. In practice, large-area man-made liners tend to leak as a result of seam imperfections and construction-related defects. These leakage rates are often characterized as being approximately equal in magnitude to low-permeability compacted earthen liners. Because the permeability of the tailings (approximately 10^{-7} meters per second) (Davies, 2001) is already in the same class as that for most typical earthen liner systems, the added benefits of installing a man-made or compacted earthen liner are concluded to be minimal.

- Lined RTP A lined RTP likely would reduce seepage loss from the facility. As a safety precaution, the system of return-flow wells downstream of the RTP should still be installed. The benefits provided by installing a liner under the RTP are considered minimal because predicted seepage rates are already expected to be low, the upstream face of the RPT dam would be lined, a hydraulic capture system downstream of the RTP would contain most of the seepage losses, and the remainder of the seepage losses would enter the mine and become incorporated into the mine water treatment system with minimal impact

Alternative 4

Tailings Facility Liner

- Lined dry stack and RTP Same as Alternative 3.

4.2.4 Options Related to Surface Access

No impacts to groundwater flows are expected.

4.2.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in no or low cumulative impacts on ground water.

- All-season Road Maintained Cumulative impacts to groundwater resources could result from development associated with timber harvesting in the Shaw Creek Valley and development of the hypothetical Sonora Creek or Slate Creek mines. Assuming that sound management practices and permitting stipulations were adhered to, timber harvesting, mining, and other resource development activities distributed over such a large area would be expected to have low cumulative impacts on ground water.

4.3 Water Quality

This section addresses both surface water and groundwater quality. Where applicable, comparisons are made to State of Alaska Water Quality Standards (18 AAC 70) and Drinking Water Standards (18 AAC 80). The most stringent applicable criteria are presented. Discharges from the project are also subject to regulation under NPDES requirements, which are administered by EPA in Alaska. In addition, an underground injection control (UIC) permit would be required for some discharge options.

All discharged waters would be expected to comply with toxicity criteria and numerical water quality standards as defined by the federal NPDES permit, UIC permit, and state discharge permit(s) or certifications of federal permit(s). Therefore, the discharges from each option are evaluated for either meeting or failing to meet those regulatory requirements with the use of the following evaluation criteria:

- No or low impact — No or very low likelihood that a discharge would exceed permit standards.
- Moderate impact — Occasional non-compliance is possible.
- High impact — High risk of not obtaining a discharge permit and, if obtained, compliance reliability is low.

For those releases from the project that are not covered by a discharge permit with specific numeric limits, a more general set of evaluation criteria has been used. These criteria would apply to situations such as accidental or unplanned releases (e.g., fuel or chemical spills) and stormwater runoff. The following metrics have been applied:

- No or low impact — No planned release or low likelihood of occurrence; if an accidental release or spill occurred, the potential for impacts to environment or public interests would be negligible. Low likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.
- Moderate impact — There is a risk of accidental release, or a release has a low likelihood of occurrence but the impacts could be high. Moderate likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.
- High impact — A high potential for accidental release exists, and the severity of the release would be high. High likelihood of stormwater runoff that would be inconsistent with the goals of the stormwater NPDES permit.

4.3.1 No Action Alternative

Without development of the Pogo project, the only proposed activity that could affect water quality would be the construction of an all-season road by the DOF along a route similar to the Applicant's proposed Shaw Creek Hillside all-season road for timber sales and subsequent logging in this area. With proper management and mitigation measures, the overall impacts on water quality are expected to be low. During road construction in the Shaw Creek watershed, disturbed surfaces could erode and increase sediment in runoff. Surface disturbance could cause increased suspended sediment in Shaw Creek and its tributaries. The increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of construction BMPs, such as silt fences, during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

During road construction and logging operations, there is also the potential for fuel spills. A fuel spill into Shaw Creek or a tributary could seriously affect water quality. The chances for a fuel spill could be greatly reduced by proper fuel management. By transferring fuel and refueling equipment only in designated areas with spill containment facilities, the likelihood for a fuel spill to affect water quality would be small.

During logging, there is also the potential for impacts to water quality from increased erosion in logging areas and release of sediment to Shaw Creek and its tributaries. With proper erosion control, setbacks from creeks, and DOF BMPs, however, this impact would be small to moderate.

Overall, the impacts on project area water quality from the No Action Alternative would be small.

4.3.2 Options Common to All Alternatives

Water quality during mine operations was estimated for each of the major sources of water to the RTP, including actual site data where available (e.g., monitoring well data and seepage from development rock piles from exploration adit), bench-scale leaching tests (humidity cell and column tests), and geochemical modeling. For each water source and each parameter, a reasonable worst-case concentration was estimated. Where appropriate, a mean and standard deviation also were estimated based on the available data for the projected water quality.

To estimate the flow and quality of the water that would be discharged under the various discharge options for excess water from the project, a mass balance model was developed (Teck-Pogo Inc., 2002b, 2002f, 2002i; Hanneman, 2003a). The water quality and flow estimates for each source of affected water were input into this model. The water balance and water quality parameters were estimated by using the probability distributions for each flow and chemical parameter in the framework of a Monte Carlo model. The flows were combined based on the project flow sheet (Figure 2.3-7).

Monte Carlo model In general, a Monte Carlo model uses statistical input data to estimate the probability of different output information. For example, given statistical data on rainfall, the Monte Carlo model could estimate a probability distribution for flow rate of a given process stream (that is related to rainfall). The model was run as a time series by using weekly time steps during a 1,000-year period to provide a statistical basis for estimating flow and water quality. Key inputs to the model include precipitation and snowmelt estimates. These inputs provide a basis for runoff volumes from project facilities. Weekly estimates of precipitation were developed from an annual average precipitation value of 19 in. as described in Teck-Pogo Inc. (2002b). The output from the model provides the probability of flows and concentrations of key process streams (e.g., discharge from the RTP). Examples of water quality output from the model include the following for each chemical constituent for key flow streams:

- 95th percentile of the annual averages
- 95th percentile of annual maximum values

The 95th percentile of the annual averages is a value that represents the ranking of the 1,000 annual averages at the 95th percentile level. It is more conservative than using an annual average concentration for comparing a projected chemical concentration to a discharge criterion. The 95th percentile of annual maximum values is a very conservative value that represents the ranking of the 1,000 annual maximum values at the 95th percentile level. Generally, both the 95th percentile of the annual averages and the 95th percentile of annual maximum values are presented when estimating discharge water quality to represent a range of conservative values.

Underground Mine

The mining of the Pogo orebody would cause the ground water in the mine area to drain into the mine workings. This action would lower the groundwater level in the area of the mine, as discussed in Section 4.2.2. This water would be collected throughout mining operations and would be pumped to a treatment plant. This section discusses water quality of the mine seepage during development and operations and after closure of the mine.

Water quality during development and operations A reasonable worst-case estimate was made of the quality of water seeping into the mine (Teck-Pogo Inc., 2002b). The quality of mine water was estimated for most parameters based on the maximum concentrations observed in the drainage from the existing exploration adit.

Arsenic concentrations were estimated by using the maximum value observed in the ground water in the ore zone from historical monitoring well data. This arsenic value was substantially higher than what had been observed in exploration adit drainage. Nitrate and ammonia are constituents that are expected to be present in the mine seepage from the explosives that are used in the mining operation. The concentrations of these two constituents would depend on the types of explosives used and how they are handled. Hence, the concentrations of these two constituents could be managed to a much greater extent by mining operational practices. The water quality estimates of mine seepage for nitrate and ammonia were based on water quality data from other mines and the expected management approach to operations and selection of types of explosives (Teck-Pogo, Inc., 2002b, Appendix C).

The estimate for cyanide was based on data from runoff and seepage from the mineralized rock pile (station SW26) (Teck-Pogo Inc., 2002b). This station contained elevated nitrate concentrations, which may interfere with total cyanide analyses (Mudder and Botz, 2002). Additionally, no cyanide had been introduced during construction of the exploration adit and no cyanide was expected to be present. Hence, the cyanide concentrations in this estimate may be overstated. Mercury concentration estimates were based on concentrations measured in the discharge from the exploration adit during a 10-day period in March and April 2000. The reasonable worst-case estimate (0.25 µg/L) was based on the maximum value measured during this period (Teck-Pogo Inc., 2002b). Subsequent monthly measurements of the seepage from the exploration adit during a 2-year period were generally non-detect at a concentration of 0.01 µg/L (Hanneman, 2003b). Hence, the reasonable worst-case value for mercury may overstate the expected concentrations. The estimate of the mine seepage water quality is presented in Table 4.3-1.

Water quality after mine closure After mining operations were complete, the mine workings would be sealed by using hydraulic plugs in the portals, vent raises, and internal development workings (Teck-Pogo, Inc., 2002b). The objective would be to prevent mine drainage from being released from the openings and to re-establish groundwater conditions similar to the pre-mining conditions. A detailed plan for plugging the mine is presented in the reclamation plan (Teck-Pogo Inc., 2002c). This plan would have to be approved by ADNR and ADEC prior to closure.

Table 4.3-1 Water Quality Estimates for Mine Seepage

Parameter	Reasonable Worst Case Untreated	Units
TSS	1,500	mg/L
TDS (fault water)	300	mg/L
TDS (mine water)	649	mg/L
Cl	5	mg/L
SO_4 (fault water)	85	mg/L
SO_4 (mine water)	283	mg/L
Ammonia	10	mg/L
TKN	10	mg/L
NO_3	10	mg/L
CN_T	20	µg/L
As	5,360	µg/L
Cd	0.5	µg/L
Cr	13	µg/L
Cu	20	µg/L
Fe	4,270	µg/L
Pb	70	µg/L
Hg	0.25	µg/L
Mn	717	µg/L
Ni	30	µg/L
Se	2	µg/L
Ag	0.1	µg/L
Zn	21	µg/L

TSS – Total suspended solids TDS – Total dissolved solids
TKN – Total Kjeldahl nitrogen CN_T – Total cyanide
Note: Concentrations are dissolved.

As discussed in Section 4.3.2 (Ground water), it would take some time to re-establish groundwater levels. Although the ore would be removed during mining, some degree of mineralization in the country rock would remain. Once the mineralized rock were sufficiently flooded, conditions would return closer to the pre-mining conditions. After flooding, the geochemical conditions are expected to become more oxygen reducing as residual sulfide minerals consume the available oxygen. The reduction of available oxygen is expected to inhibit further oxidation of the remnant iron-sulfide minerals. Within the backfilled tailings, the pH would be elevated from the presence of cement in the paste backfill. The combination of higher pH and reduced oxygen conditions likely would result in some solubility of arsenic, but would further decrease the oxidation of remnant iron-sulfide.

Backfilling of the mine workings with cemented tailings and plugging of other openings would limit the water flow through the backfilled mine. This would result in limited transport of the soluble constituents from the mined area through the less permeable surrounding rock. The condition would be analogous to the current baseline conditions, in which there is an area of elevated arsenic concentrations (currently up to 5 mg/L), but the transport of the arsenic is limited.

Assuming effective plugging of the mine, estimates of the transport of arsenic, TDS, and selected metals were made by using groundwater flow and contaminant transport modeling (Brown, 2001). The modeling evaluated the transport of the dissolved constituents from the backfilled mine through the bedrock to the valley alluvium to the Goodpaster River. These estimates were made under a variety of assumptions, including the degree to which arsenic, metals, and cyanide dissolve from the backfill, variations in bedrock and alluvium hydraulic conductivity, variations in infiltration, variations in porosity, and the degree of adsorption of constituents to the rock surfaces during transport.

The results demonstrated that the factors that had the greatest impact on estimated water quality were the degree to which the arsenic and metals dissolved from the backfill over time and the degree to which these constituents adsorbed to the rock surfaces as the groundwater flowed from the backfilled mine. A summary of the results of these estimates for selected conditions is presented in Table 4.3-2 for arsenic, TDS, and cyanide. This table presents the estimated maximum increase in concentration over the existing conditions estimated to occur over time for four cases. This table presents the estimated increase in concentrations at three locations:

- Slope alluvium: unconsolidated material on the valley slopes
- Valley alluvium: sands and gravels in the valley bottom
- Goodpaster River: concentrations based on a flow of 33 cfs in the river

Table 4.3-2 Estimated Long-Term Increase over Baseline in Arsenic, TDS, and Cyanide Concentrations in Water after Mine Closure

	Increase in Arsenic Concentration (µg/L)			Increase in TDS Concentration (mg/L)			Increase in Cyanide Concentration (µg/L)		
	Slope Alluvium	Valley Alluvium	River	Slope Alluvium	Valley Alluvium	River	Slope Alluvium	Valley Alluvium	River
High adsorption on rock surfaces minimum amount of source dissolved	<1	<1	<1	291	16	1	23	1	<1
No adsorption on rock surfaces minimum amount of source dissolved	250	14	1	291	16	1	23	1	<1
High adsorption on rock surfaces maximum amount of source dissolved	496	27	2	576	32	2	42	2	<1
No adsorption on rock surfaces maximum amount of source dissolved	497	27	2	577	32	2	43	2	<1

Data from Brown (2001)

The concentrations in both tables represent the estimated maximum increases in concentration that would occur for each location and set of assumptions. The time interval to reach these maximum values varies substantially between the different parameters. For example, it was estimated that it would take more than 100 years for the TDS and cyanide concentrations to reach their maximum, while it would take tens of thousands of years for the arsenic concentrations to reach their peak given the potential for arsenic to attenuate on the rock surfaces.

These estimates indicate there is potential for increased concentrations of contaminants downgradient of the mine over the long term. The cyanide concentrations may be somewhat conservative because of the degradation of the cyanide that may occur over time that was not accounted for in the contaminant transport model. Increased concentrations would be most notable in the slope alluvium with lower increases in the valley alluvium. The small increases in concentrations estimated for the Goodpaster River likely would not be detectable. Increased concentrations in the slope and valley alluvium may be detectable and could result in ground water at some locations that are currently near an arsenic concentration of 50 μg/L eventually exceeding this value. However, it is estimated that it would be a long time before these concentrations would reach their maximum levels, possibly in the thousands of years. Hence, this impact is expected to be moderate and would be localized in the area of the mine and adjacent slope and valley alluvium.

- Underground Tailings Disposal

  All tailings from the cyanide leach circuit and approximately one-half of the flotation tailings produced would be dewatered, mixed with cement, and placed underground in previously mined areas. The majority of the tailings placed underground would be as a paste backfill. A small portion of the tailings would be placed without cement.

  The quantity of water projected to drain from the backfill is expected to be small. It is estimated that the average flow would be approximately 2 gpm (Teck-Pogo Inc., 2002b). This water would flow from the backfill into the mine workings and would then be pumped out of the mine with the mine seepage.

  Backfill seepage water would have a quality similar to the process water that would be entrained in the backfill. The estimate of this water quality was based on the results of pilot-scale tests conducted to evaluate cyanide leaching and cyanide destruction. Analyses of the water entrained in the tailings after cyanide destruction form the basis for this water quality estimate. For several parameters (cyanide, copper, iron, lead, zinc, and nickel), the projected concentrations used as model input were greater than the concentration measured in the bench-scale tests to account for the differences between bench- and full-scale operations. The predicted concentrations were derived from the performance of operating facilities (Nethery, 2000; Nethery, 2001; Nethery and Higgs, 2001). The estimated water quality for the backfill drainage is presented in Table 4.3-3. Because this water would be collected and treated with the mine seepage water, there are no separate impacts from this water during operation. The potential impacts of the backfilled tailings on water quality after closure are discussed under the previous mine closure section.

Table 4.3-3 Water Quality Estimates for Backfill Drainage

Parameter	Mean	Standard Deviation	Reasonable Worst Case Untreated	Units
TSS			250	mg/L
TDS			13,700	mg/L
Cl			27	mg/L
SO_4			6,800	mg/L
TKN	15	13	64	mg/L
NO_3			2.39	mg/L
CN_T			1,000	µg/L
As			5,600	µg/L
Cd			10	µg/L
Cr			20	µg/L
Cu			1,000	µg/L
Fe			3,000	µg/L
Pb			30	µg/L
Hg			3	µg/L
Mn			10,100	µg/L
Ni			370	µg/L
Se			430	µg/L
Ag			2.4	µg/L
Zn			430	µg/L

Note: Concentrations are dissolved Teck-Pogo Inc. (2002b, Appendix H)

- Surface Dry Stack and RTP in Liese Creek

  - Surface Dry Stack Water quality estimates for seepage and runoff from the tailings dry stack are presented in Table 4.3-4. These estimates are based on site data, testwork, and geochemical modeling. The bases for these estimates are presented in (Teck-Pogo Inc., 2002b, Appendix C). It is projected that the seepage water quality would remain relatively consistent over the life of the project and after closure. The seepage quantity would be relatively low and would decrease with time, however, as the moisture in the dry stack drained. This decrease in seepage would be due primarily to the very fine-grain compacted tailings with low hydraulic conductivity as previously discussed in Section 4.2.2.

Table 4.3-4 Water Quality Estimates for Tailings Dry-stack Seepage and Runoff

Parameter	Tailings Runoff	Tailings Seepage			Units
	Reasonable Worst Case	Mean	Standard Deviation	Reasonable Worst Case	
TSS	400			5	mg/L
TDS	523	600	610	3,000	mg/L
Cl	164	12.2	12.3	34	mg/L
SO_4	302	57.4	125	2,000	mg/L
TKN	0.5	1	1	17.8	mg/L
NO_3	19.8			4	mg/L
CN_T	20			50	µg/L
As	400	1,600	2,000	5,100	µg/L
Cd	0.4	0.35	2	5	µg/L
Cr	1.1	2.51	3.4	14	µg/L
Cu	3	4	7	34	µg/L
Fe	0.3	2,000	22,000	29,600	µg/L
Pb	0.4	0.9	2.5	5	µg/L
Hg	0.2	0.189	0.376	2	µg/L
Mn	380	108	182	4,750	µg/L
Ni	20	25	120	240	µg/L
Se	6	13	50	130	µg/L
Ag	0.2	0.069	0.064	2	µg/L
Zn	60	50	335	700	µg/L

Note: Concentrations are dissolved

The runoff water quality also would be relatively consistent over the life of the project. Some erosion of the dry-stack tailings would occur in the runoff during operation. Mitigation measures would be employed to reduce erosion, but some would occur. This erosion would result in somewhat increased suspended solids in the section of Liese Creek below the dry stack and deposition of tailings in the RTP.

The removal of topsoil and placement of 1.5 feet of nonmineralized development rock on the dry-stack facility footprint as an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact either the quantity or quality of the seepage from the dry stack.

During operation, the impacts on the water quality in the reach between the dry stack and the RTP are expected to be moderate. This reach of creek would act as a drain from the dry stack to the RTP. The majority of the flow in this reach would be from dry-stack runoff with a small contribution of dry-stack seepage. During operations, most of the seepage would flow to the RTP where it would either be recycled to the mill or discharged after treatment. A small percentage of dry-stack seepage might flow to the groundwater flow system that contributes to the mine inflows. These waters would also be collected as part of the mine inflow collection, use, and treatment system.

After mine closure, the need to continue operation of the RTP would be evaluated. The RTP and water treatment system would remain in place as long as needed to treat the dry-stack runoff and seepage. When mining operations were complete, the dry stack would be closed with a soil cover and would then be revegetated. Erosion of the dry stack would diminish greatly after closure of the dry stack. When reclamation activities were completed, minimal erosion would be expected. Runoff quality would be greatly improved after closure. The improved quality of runoff would improve the water quality in the reach of Liese Creek between the dry stack and the RTP. After closure, the impacts on this reach of Liese Creek would be low. After reclamation of the site and the attainment of applicable water quality standards from any remaining sources to the RTP, the RTP would be reclaimed.

- RTP Seepage from the RTP is expected to be small, approximately 5 gpm, and would be collected by a series of collection wells below the dam. Seepage that is not collected by the seepage collection wells is expected to enter the groundwater flow system entering the mine. Impacts on Liese Creek water quality below the dam during operation would be low. An estimate of the projected water quality of the water in the RTP is presented in Table 4.3-5.

Table 4.3-5 Projected Water Quality of Water in the RTP

Parameter	Mean Annual Average Dissolved	95% Annual Average Dissolved	95% Annual Maximum Dissolved	Units
TSS	32.4	89.4	262	mg/L
TDS	281	396	559	mg/L
Cl	85.1	228	573	mg/L
SO_4	102	168	230	mg/L
TKN	2.31	4.86	8.94	mg/L
NO_3	7.04	13.8	18.1	mg/L
CN_T	12.5	17.2	30.3	µg/L
As	184	488	1,136	µg/L
Cd	0.17	0.27	0.35	µg/L
Cr	3.14	6	11.6	µg/L
Cu	5.13	7.67	9.85	µg/L
Fe	678	1,230	1,660	µg/L
Pb	0.52	0.9	1.15	µg/L
Hg	0.0731	0.104	0.17	µg/L
Mn	364	885	1,320	µg/L
Ni	5.88	14.4	29.7	µg/L
Se	2.52	5.04	9.79	µg/L
Ag	0.06	0.08	0.1	µg/L
Zn	30.4	54.1	78.9	µg/L

As discussed in Section 4.1.2, there is the potential for the RTP to overtop and discharge during operations. This type of discharge is considered a low potential upset condition wherein the storm event(s) exceed applicable facility design criteria, resulting in an emergency spillway overflow condition rather than a planned discharge. The RTP is designed to contain 40 million gallons. As discussed in Section 2.3.9, the RTP has been designed to contain the runoff from the 24-hour, 100-year storm event and snowmelt runoff from the project. The Applicant has not proposed a discharge of untreated water over the RTP dam, and substantial design efforts have been made to reduce the risk of such a release to a statistically small level. There would still be a possibility, however, the RTP could overtop in a very large storm event, as discussed in Section 4.1.2 (Surface Water Hydrology). The Monte Carlo model estimated the RTP would overtop and discharge without treatment only infrequently (22 times in 1,000 years for Alternative 2 and 45 times in 1,000 years for Alternative 4) during major storm or runoff events. During such a release, the discharged water would flow down the spillway of the RTP, combine with water diverted from the upper part of the Liese Creek drainage basin, flow down Liese Creek, through the wetlands that separate Liese Creek from the Goodpaster River, and discharge to the Goodpaster River.

An estimate of the water quality impacts of such an event on the Goodpaster River was made by estimating the water quality in the RTP during a discharge event by using the Monte Carlo model. The projected water quality for the discharge from the RTP, water quality in the Goodpaster River during a storm event, and resulting water quality of the Goodpaster with the addition of the water from the RTP is presented in Table 4.3-6. As this table shows, the water from a RTP direct discharge is estimated to have higher concentrations of all constituents than the Goodpaster River water during a storm event. The Goodpaster River data is actual data collected during an August 2000 storm event. The mixing of the RTP discharge with the Goodpaster stormwater would result in small increases for a number of Goodpaster River water quality parameters. These predicted changes are within the range of analytical measurement variability, and the impact on the Goodpaster River would be characterized as low. Because of the infrequent nature of this event and the small decrease in water quality in the Goodpaster River, this release would have a minor impact to the Goodpaster River water quality.

As discussed previously, after closure when the RTP would no longer be needed to capture seepage and runoff from the dry-stack tailings, it would be drained and breached. The water drained from the RTP would be passed through the water treatment plant prior to discharge. After breaching the RTP, seepage from the RTP would no longer occur. Tailings that were deposited in the RTP from erosion of the dry stack during operation would be consolidated and capped at closure of the RTP (Teck-Pogo Inc., 2002c). Consolidation and capping would minimize the potential for the RTP to release sediment after closure.

Table 4.3-6 Projected Water Quality of Stormwater Discharge from RTP, Goodpaster River, and Goodpaster River with Addition of Water from RTP

	RTP	Goodpaster River		
Parameter	95% of Annual Maximum of Stormwater Discharge	Goodpaster (SW15) During Storm Event	95% of Annual Maximum with Addition of RTP Stormwater Discharge	Units
TSS	162	46	46	mg/L
TDS	407	59	62	mg/L
Cl	74	0.1	0.26	mg/L
SO_4	179	9.5	9.56	mg/L
TKN	3.3	0.6	0.6	mg/L
NO_3	13.6	0.2	0.28	mg/L
CN_T	13	5	5.2	µg/L
As	120	1.3	1.8	µg/L
Cd	0.26	0.03	0.031	µg/L
Cr	5.3	2.5	2.5	µg/L
Cu	7.4	1.9	1.9	µg/L
Fe	4,220	1,460	1,460	µg/L
Pb	1.53	0.85	0.85	µg/L
Hg	0.085	0.01	0.01	µg/L
Mn	860	60	60	µg/L
Ni	7.8	2	2	µg/L
Se	2.5	0.5	0.52	µg/L
Ag	0.16	0.01	0.01	µg/L
Zn	68	4.1	4.1	µg/L

Note: Concentrations are dissolved

Mill and Camp Location

The mill and camp facilities would be located in Liese Creek drainage. Diversion ditches would be constructed to divert clean runoff away from these facilities to minimize the quantity of contact runoff from these facilities. All stormwater from these facilities would be collected in a sump and pumped to the RTP. The pumps in this sump would be connected to emergency standby power. In the event of failure of the pumps or failure of both primary and backup power, the runoff from the mill and camp would be directed into the underground mine, where it would be stored until it could be pumped to the RTP. As described in Section 2.3.10, the RTP water would be treated prior to discharge.

Blind sumps and secondary containment would be used in the mill to minimize the potential for spills within the mill building to mix with stormwater, as described in Section 2.3.19. Use of sumps and containment would prevent reagent or mill process water spills from mixing with stormwater and would minimize the potential that contaminants from these materials would enter the RTP. With the planned stormwater controls, the impact of the mill and camp on Liese Creek water quality is expected to be low.

Milling Process

As discussed in Section 2.3.9, the milling process would maximize the use of recycle water and minimize the use of fresh water. Process water is only released from the mill in the water that is entrained in the tailings that are placed underground or in the surface dry stack.

The cyanide circuit would be kept fully isolated from the other portions of the processing; therefore, the only release of cyanide-containing fluids would be in the cyanide leach tailings that would be placed underground as paste backfill. These tailings would be treated to destroy cyanide prior to being placed as backfill; however, there would still be residual cyanide in these tailings. The impact of this residual cyanide would be to contribute cyanide to the mine drainage from the backfilled tailings, as discussed in Section 2.3.6.

In the milling process, the management of spills, as described in the previous section, would minimize the potential for reagents or process water to mix with other waters on the project. Milling reagents would be stored adjacent to the mill in a covered building with concrete diked areas (Section 2.3.17). This would minimize the potential that reagent spill would affect process water quality or migrate out of the mill facility.

Development Rock Disposal

As discussed in Section 2.3.8, two basic types of development rock (mineralized and nonmineralized) would be produced during mine development and operation. Development rock that is referred to as “nonmineralized” may be more technically described as “weakly mineralized”; however, the term nonmineralized is used in this discussion for consistency with previous documentation. Evaluation of the ability of development rock to release contaminants was tested using laboratory tests and monitoring of the development rock piles that were produced during construction of the exploration adit. The mineralized and nonmineralized development rock would be managed differently, and, hence, a primary goal of the studies conducted was to develop criteria to distinguish mineralized from nonmineralized development rock.

Development rock testing The potential for release of contaminants from development rock was evaluated using acid-base accounting (ABA) testing and kinetic laboratory testing. ABA testing provides information on the quantities of potential acid generating and acid neutralizing minerals in the development rock. The kinetic tests are small scale tests that subject samples to conditions that simulate leaching that may take place during operations. The kinetic tests are run for long periods of time (several years) and leachate is monitored from the tests. A description of the tests is presented in Day (2000).

ABA testing was conducted on approximately163 ore and development rock samples from numerous rock types from the 1998 delineation drilling. Based on these results, samples were selected for additional testing. ABA and kinetic testing were subsequently conducted on 13 development rock samples. The rock samples were selected from locations that had a high likelihood of being mined or being exposed during mining. The samples were taken from locations to provide an even spatial coverage of rock to be mined. The availability of sufficient sample also was a factor in sample selection. Other key considerations were mineralogy of rock samples and arsenic content. Rock samples selected had average or higher than average arsenic content for the given rock type. These samples contained arsenic in the range of 6 to 7,400 mg/kg, and sulfur in the range of 0.08 to 2.98 percent. Rock types tested included gneiss, granodiorite, and altered rock near the ore vein.

Testing results on the development rock indicated:

- Acidic leachate would come from development rock (and ore samples also tested) that had a neutralizing potential to acid generating potential ratio (NP/AP) of less than 1.4.

- The initial NP/AP data on the larger sample set (163 samples) indicated that very few samples with a sulfur content less than 0.5 percent had the potential to generate acid (Day, 2002b).
- Sulfate release rates generally increased with increased sulfur content in the rock.
- Arsenic release rates were not well correlated to the arsenic content in the rock, particularly at low arsenic concentration. This was due in part to the presence of the mineral lollingite (FeAs2). One sample was specifically selected with lollingite for ABA and kinetic testing to determine its response. Testing indicated that arsenic was released more rapidly from lollingite than from other arsenic containing minerals. Mineralogical evaluations indicated that lollingite was not common in the development rock or the ore (Day, 20022b).
- Of the 13 development rock samples tested, one sample (0.87 percent sulfur and 1477 mg/kg arsenic) became acidic (approximately pH 4). The other samples produced water that was near neutral or was alkaline. Arsenic release rates were highest for the one sample that became strongly acidic (0.14 mg/kg/week) (Teck-Pogo, Inc., 2003b, Appendix C).
- Other than the sample that contained lollingite, release rates of arsenic were low (maximum of 0.009 mg/kg/week) for samples with bulk arsenic concentrations up to 1000 mg/kg.

Exploration adit development pile monitoring During construction of the exploration adit, development rock was segregated into two categories based on sulfur and arsenic content. Development rock containing greater than 0.5 percent sulfur or 200 ppm arsenic was classified as “mineralized” development rock, and rock with concentrations less than both of those values was classified as “nonmineralized” development rock.

Development rock generated from the exploration adit included 82,000 tons of nonmineralized development rock and 44,000 tons of mineralized development rock. The mineralized and non-mineralized development rock piles had average arsenic concentrations of 592 and 43 ppm, respectively. The average sulfur concentrations were 0.62 and 0.21 percent, respectively. Each development rock type was placed on a lined pad below the existing 1525 Portal for collection of seepage water that migrated through each pile.

Seepage from the development piles was monitored. Initial monitoring began in August 1999 with a full set of parameters starting in April 2000. Monitoring data through July 2002 was reviewed for this document. Dissolved arsenic concentrations ranged from <.05 to 17 µg/L for the mineralized rock (monitoring station SW 26) and 2 to 12.9 µg/L for the nonmineralized rock (monitoring station SW 25B). No discernable trends were identified in arsenic concentrations with time for either pile. Dissolved cadmium concentrations in the nonmineralized pile runoff ranged from <0.05 to 4.6 µg/L, with a generally decreasing trend in concentration. Dissolved cadmium concentrations in the seepage from the mineralized pile were low with all concentrations below 0.5 ug/L. Dissolved zinc concentrations were generally low (concentrations less than 50 ug/L) from the nonmineralized rock pile at monitoring station SW25B; however, 7 of the 38 samples taken during the monitoring period were greater than or equal to 50 µg/L, with the highest concentration being 1800 ug/L.

It should also be noted that the pH for the seepage from the nonmineralized pile was depressed, especially through 2000, due to oxidation of ammonia from residual explosives (Day, 2001). During this period, the field pH was generally in the 6 to 7 range. In 2001, the pH was in the upper 6 range (generally 6.5 to 6.9 for the field measured pH.) The pH of the mineralized pile was generally in the 7 to 8 range throughout the monitoring.

Evaluation of testing and monitoring data Results of the sample testing program and development rock monitoring were used to characterize the reactivity and leachablity of the development rock to provide information that would be used to guide development rock management. A key question was which material could be treated as nonmineralized rock with little potential to release contaminants and which material would require special considerations for storage and disposal. This question focused on the upper limits for arsenic and sulfur concentrations for nonmineralized development rock. An arsenic cutoff concentration of 200 mg/kg was proposed by the Applicant prior to constructing the exploration adit in 2000. A value of 600 mg/kg was subsequently proposed in the Applicant's February 2002 Plan of Operations.

Other questions concerned the adequacy of the number of samples of development rock tested, the importance of the presence of lollingite in the development rock, interpretation of the monitoring data for exploration development rock piles seepage, and the quantity of development rock expected to fall within the arsenic concentration range of 200 to 600 mg/kg.

Kinetic testing included 13 different samples of development rock that were run in 19 different tests. The additional tests included the replicate tests and tests conducted on the same samples but at low temperatures. One sample became acidic during testing. This sample had a greater arsenic release rate than others tested. One sample was selected because it contained lollingite, and as discussed previously, this sample had a markedly different behavior (higher leaching) rate than the other non-acid generating samples. Hence there were 11 samples tested that were not acid generating and that did not contain significant amounts of lollingite. Of these 11 samples tested, four had arsenic concentrations greater than 60 mg/kg. Although these samples were selected to represent the range of development rock encountered, because of the small number of samples tested it will be necessary to consider these test results in conjunction with the results for the monitoring of seepage from the large development rock piles.

Presence of lollingite is a concern because it can result in relatively rapid arsenic release at low concentrations of arsenic. In the kinetic (humidity) cell tests, samples containing lollingite with arsenic concentrations of 142 mg/kg had the highest release rates of all samples tested (0.07 to 0.12 mg/kg/week) for the 12 non-acid generating samples (arsenic range of 6 to 7400 mg/kg). These release rates were three to 10 times higher than the next highest non-acid-generating development rock release rates sample (0.007 to 0.02 mg/kg/week). The development rock samples that had the next highest release rates had arsenic concentrations of 4300 mg/kg. These results are a potential concern because they indicate that it may be difficult to establish a cut-off concentration for arsenic due to the significant leaching that occurred relatively rapidly for samples with low arsenic concentrations. It is reported based on mineralogical analysis, however, that lollingite is an uncommon mineral in the Pogo development rock (Day, 2002b). The mineralogical analysis indicated that when lollingite was observed in development rock it was commonly present "as typically rare scattered grains" (Teck-Pogo Inc., 2002k).

Results from mineralized and non-mineralized exploration rock piles indicated arsenic release from both piles was low, with low resulting concentrations in the runoff and seepage from each pile. One concern with the monitoring data from the piles' discharges is the limited monitoring period of approximately two years. There is the potential for conditions in the piles to change with time as sulfide minerals are oxidized, resulting in higher releases of arsenic. Kinetic testing, however, indicated that high arsenic releases resulting from sulfide oxidation occur in samples with higher sulfide concentrations. This likely would not occur in the nonmineralized rock pile. The NP/AP data indicated that very few samples with a sulfur content less than 0.5 percent had the potential to generate acid.

An additional concern is that because the pH of seepage from the nonmineralized rock pile was lowered by oxidation of residual explosives, as previously described, there is a possibility that arsenic was attenuated. Arsenic is less mobile in the presence of ferric iron at pH 6 to 7 than above 7. The concern is that the lower pH that was observed in the nonmineralized seepage would not normally be present with nonmineralized development rock, and without this lower pH, higher arsenic concentrations in the seepage may be observed. Review of the pH of the seepage from the mineralized development rock shows higher pH measurements with readings generally in the 7 to 8 range. Arsenic concentrations in seepage from the mineralized rock piles were very slightly higher than the nonmineralized values, but still less than 20 µg/L. Therefore, assuming that the mineralized and nonmineralized rock had similar lollingite concentrations, it is unlikely that substantially higher arsenic concentrations would have been released from the nonmineralized development rock even if the pH had been higher.

Because release of arsenic has been low during the two years of the rock piles seepage and runoff sampling, it is likely that lollingite is not a significant contributor to arsenic release. The humidity cell tests indicated that the development rock samples containing lollingite had a high initial release rate and then decreased over time. If lollingite was present in appreciable quantities in the development rock, higher initial arsenic concentrations would have been expected in the discharge from the exploration development rock piles.

The Applicant's estimate of the quantity of development rock that would fall into the category of less than 0.5 percent sulfur and between 200 and 600 mg/kg arsenic was four percent of the development rock to be produced. This estimate was based on the analysis of material from the exploration adit and the assumption that a similar distribution of concentrations would be found in additional development work. For the exploration adit, if the arsenic cutoff had been set at 600 mg/kg the average of the nonmineralized stockpile would have increased from 43 to 56 mg/kg. The proportions of development rock with arsenic concentrations below 200 mg/kg and between 200 and 600 mg/kg could be different during future development with concentrations of arsenic potentially higher closer to the ore body.

Evaluation of impacts from development rock During mine development, mineralized and nonmineralized development rock would be managed separately. During operations, all development rock would be handled as mineralized rock unless otherwise analyzed and segregated on a round-by-round basis. During the course of the entire project, approximately 436,000 tons of mineralized development rock would be placed underground and, 237,000 tons would be placed on the surface in the tailings dry stack. Approximately 411,000 tons of nonmineralized development rock would be placed underground, and an additional 840,000 tons of nonmineralized development rock would be placed on the surface (Teck-Pogo 2002i). The following paragraphs evaluate this approach. This is followed by an evaluation of the benefits and impacts of placing the additional 237,000 tons of mineralized development rock underground in place of nonmineralized material.

The estimated 237,000 tons of mineralized rock to be placed on the surface ultimately would be encapsulated in the surface dry stack, which would minimize release of contaminants from this material over the long term. The compacted dry-stack tailings would have a very low hydraulic conductivity (estimated at 3.5×10^{-9} meters per second) that would minimize water contact and contaminant transport from mineralized development rock. Prior to producing sufficient tailings for encapsulation, however, the mineralized development rock would be stored in upper Liese Creek Valley within the planned dry stack footprint (Figure 2.3-1 e). It is projected that all mineralized rock brought to the surface would be encapsulated in the dry-stack tailings pile by year 7 of the project.

Estimated water quality of the mineralized development rock seepage is presented in Table 4.3-7**.** This estimate is based on site data, testwork, and geochemical modeling (Teck-Pogo Inc., 2002b, Appendix C). The seepage and runoff from the temporary mineralized development rock disposal pile would flow to the RTP, with small quantities entering the groundwater flow system that contributes to mine inflows. This flow would have a moderate to high impact on the groundwater concentrations under the mineralized rock, and would occur between the mineralized rock storage and the RTP. This impact to ground water would be localized to this area and would not extend below the RTP. There also would be a moderate to high impact to surface water due to runoff from the mineralized development rock pile. These impacts to Liese Creek would be localized and confined to the area between the mineralized development rock pile and the RTP.

Table 4.3-7 Water Quality Estimates for Mineralized Development Rock Seepage

Parameter	Mean	Standard Deviation	Reasonable Worst Case Untreated	Units
TSS	33.3	45.7	107	mg/L
TDS	435	117	772	mg/L
Cl	37.3	27.7	89	mg/L
SO_4	634	295	386	mg/L
TKN	10	1.8	15	mg/L
NO_3			9	mg/L
CN_T			20	µg/L
As	180	180	500	µg/L
Cd	0.5	1.4	5	µg/L
Cr	2.58	3.52	14	µg/L
Cu	4	2	30	µg/L
Fe	521	522	1,450	µg/L
Pb	0.9	2.5	5	µg/L
Hg	0.144	0.413	2	µg/L
Mn	235	666	980	µg/L
Ni	20	73	236	µg/L
Se	4	16.5	30	µg/L
Ag	0.029	0.024	2	µg/L
Zn	50	335	699	µg/L

Note: Concentrations are dissolved

Nonmineralized development rock is rock that has low levels of arsenic and sulfur and has a low potential to release contaminants when exposed to the environment. It would be used to construct the dry-stack toe berm, roads, and the RTP. Based on humidity cell and column leaching tests and the seepage data from the current piles of development rock from the exploration adit (Teck-Pogo Inc., 2002g; Hanneman, 2002e), the nonmineralized rock would be rock with less than 0.5 percent sulfur and less than 600 milligrams per kilogram of arsenic concentrations. Runoff and seepage from the nonmineralized rock would be expected to have low concentrations of arsenic and metals; therefore, they would have a low impact on water quality.

As an alternate approach, all of the mineralized rock could be placed underground in mined stopes. This would provide a secure long-term storage location. Such underground storage would provide the same degree of isolation expected for the backfilled tailings placed underground.

Because of mining logistics, the estimated total of 237,000 tons of mineralized rock likely would need to be temporarily stored on the surface and placed underground later as mine operations permitted. This would result in double handling this material. Estimated water quality coming from underground would be the same whether or not mineralized development rock were placed underground (i.e., the placement of additional mineralized rock underground would not be expected to result in lower water quality from the underground workings). The additional cost for placement of mineralized development rock underground was estimated to be $1.3 million (Hanneman, 2003d).

Encapsulation of mineralized development rock in the tailings dry stack is also expected to provide a secure long term storage location. It is expected that seepage from the dry stack would have similar chemical characteristics whether or not the mineralized development rock were encapsulated in the dry stack. Hence, the water quality model input was selected such that the mineralized development rock on the surface would not be considered a source of degraded water quality once it were placed in the dry stack.

From a water quality perspective, the difference in placement of the 237,000 tons of mineralized development rock underground, as compared to encapsulation in the dry stack, would be small. Although there may be a small increase in the level of protection by placement of this mineralized rock underground, the difference is believed to be sufficiently small that it would not change the estimate of water quality for the system.

Gravel Source

- Expand Existing Gravel Pits and Develop New Pits Under this component option, the existing gravel pit near the 1525 Portal would be expanded and new gravel pits would be excavated adjacent to the proposed 3,000-ft airstrip, elsewhere in the Goodpaster River Valley, and in Liese Creek Valley. The gravel from these pits would be used to provide construction materials for project facilities. Because portions of the pits on the Goodpaster River Valley floor likely would be below the water table, the pits would contain water. It is likely that there would be elevated levels of suspended solids during excavation of these pits. These pits would not have a connection with other surface water bodies (i.e., Goodpaster River) during development, however, and there would be minimal impact from the gravel pits on water quality of other water bodies.

- Crush Development Rock The use of nonmineralized development rock for other construction purposes would have minimal impact on water quality. This option, however, would require careful testing and sorting of development rock to ensure that the rock used for general construction purposes did not have the potential for long-term release of contaminants. It is expected that this testing and sorting could be implemented and that crushed nonmineralized development rock would have a low impact on water quality. The use of nonmineralized development rock as construction materials would decrease the volume of gravel that would need to be mined.

Laydown Area

The permanent laydown areas would be located below the 1525 Portal, adjacent to the airstrip, and near the mill. Materials to be stored in the laydown areas would include piping, equipment that is not in use, and various materials. Mill reagents would not be stored in the laydown areas but would be transported directly to the mill building for storage. No hazardous materials would be stored in the laydown areas. The impacts of laydown areas on water quality would be minimal.

Water Supply

Industrial

- Mine drainage The use of mine drainage as a source of industrial water supply for mill make-up water would reduce the quantity of mine water that would need to be treated and discharged compared to the use of fresh water for make-up water.
- RTP The use of RTP water as a source of industrial water supply for mill make-up water would reduce the quantity of mine water that would need to be discharged after treatment in comparison to the use of fresh water for make-up water.
- Wells During the periods when there were an insufficient quantity of water from mine drainage or the RTP, water from wells would be used to serve industrial needs. Because well water would not be used when other industrial sources were available, the use of well water would not contribute to additional quantities of water that would need to be discharged. Water pumped from wells for mill make-up water would ultimately be entrained in the tailings. The impacts of using well water under these circumstances would be minimal.

Domestic

- Wells No direct water quality impacts are expected to result from the use of groundwater wells for domestic supply.

Water Discharge

- Domestic Wastewater Domestic waste would be treated with a single ADEC-approved sewage treatment plant with a capacity of 75,000 gpd that would serve both the construction camp and the Liese Creek construction/permanent camp. This plant would be constructed below the 1575 Portal, and would discharge directly to the Goodpaster River at a point 0.2 miles below the construction camp.

  The domestic wastewater treatment system would be constructed for a maximum capacity of 700 residents anticipated during the construction phase (200 residents at the 1525 Portal construction camp and 500 residents at the Liese Creek camp). The anticipated domestic water use rate of 100 gpd per resident would result in a maximum domestic wastewater flow of 49 gpm (70,000 gpd).

  During the construction phase, domestic wastewater would be pumped from the construction camp to the sewage treatment plant. During the early portion of the construction/permanent camp development, domestic waste would be either trucked or pumped through a pipeline to the treatment plant.

  During the operations phase, lift stations in each of the main buildings would pump domestic waste to an aerated storage and collection tank near the mill. The waste then would be gravity fed to the treatment plant. The number of residents contributing to the domestic wastewater system would drop from 700 during construction to 250 during the operational phase. The anticipated domestic water use rate of 100 gallons gpd per resident would produce an average domestic wastewater flow of 17 gpm, or a total of 25,000 gpd.

  The domestic wastewater treatment plant would use high intensity ultraviolet for disinfection prior to discharge. Treated effluent would be discharged directly to the

Goodpaster River at a maximum rate of 50 gpm under an NPDES permit (Teck-Pogo Inc., 2002i).

The projected effluent water quality from the domestic wastewater treatment system is:

- Total suspended solids (TSS): 30mg/L monthly average, 60 mg/L daily maximum
- Biochemical oxygen demand (BOD): 30 mg/L monthly average, 60 mg/L daily maximum
- Fecal coliform (FC): 200 count/100 milliliters (mL) monthly average, 400 count/100 mL daily maximum

Table 4.3-8 presents a summary of the pertinent parameters of the background water quality of the Goodpaster River pertaining to a domestic wastewater discharge (Design Science & Engineering, 2002). This background water quality was used to conduct a mixing zone study of the treated domestic wastewater discharge.

Table 4.3-8 Goodpaster River Background Water Quality

Parameter	Number of samples	Median	Mean	5th Percentile	95th Percentile
BOD5 (mg/L)	N/A				5 (estimate)
TSS (mg/L)	35	25	4.5	1.5	14.3
TKN (mg/L)	26	0.13	0.19	0.05	0.48
FC (FC/100 mL)	N/A				5 (estimate)
pH (su)	29	6.9	6.9	6.1	7.7
DO (mg/L)	26	11.6	11.9	9.5	14.3
DO (%)	25	94.3	90.3	72.8	99.1
Temperature (deg C)	31	2.9	4.9	0.1	12.1

BOD – Five-day biological oxygen demand
TSS – Total suspended solids
TKN – Total Kjeldahl nitrogen
FC – Fecal coliform bacteria
pH – Standard units
DO – dissolved oxygen

Table 4.3-9 summarizes the results of the mixing zone analysis based on conservative predictions of the effluent water quality anticipated from the domestic wastewater treatment system. The parameter that would require the largest mixing zone dilution ratio based on a mass balance approach is fecal coliform bacteria. With the use of a conservative effluent discharge maximum of 50 gpm, the proportion of the stream providing dilution is 2.9 cfs, which constitutes approximately 7 percent (Design Science & Engineering, 2002) of the design 2-year 3-day (3Q2) low-flow event applicable to conventional and nontoxic substances (18 AAC 70.255).

Table 4.3-9 Predicted Effluent Concentrations and Mixing Zone Analysis Results[1]

Parameter	Effluent Minimum Value	Effluent Maximum Value	Effluent Monthly Average	Effluent Daily Maximum	Effluent Target Criteria	Model Input Effluent Value	Minimum Dilution Ratio	Expected Conc. at Mixing Zone Edge
BOD5 (mg/L)	N/A	N/A	30	60	30 mg/l			7
TSS (mg/L)	N/A	N/A	30	60	30 mg/l			16
TKN (mg/L)	N/A	N/A	15	30	<=10	30	2.1	1.6
FC (FC/100mL)	N/A	N/A	200	400	<=20	400	25.3	20
pH (su)	6.0	9	8	N/A	6.5-9.0			
DO (mg/L)	1.0	N/A	2.0	N/A	>=7.0	1	2.4	9.2
Temp (deg C)	N/A	N/A	15	20	<=15	20	1.7	12

[1] The NPDES permit may analyze other parameters of concern.

The results of the modeling to determine the size of the minimum mixing zone and computations to determine the dissolved oxygen sag indicate that all water quality standards could be met within a regulatory mixing zone that is 5 ft long, by 5 ft on the upstream edge and 7 ft along the downstream edge, which is approximately 22 percent of the wetted stream width of the modeled location, during the 3Q2 low-flow event (Design Science & Engineering, 2002). Under the conservative design and computational input parameters, the discharge of domestic wastewater to the Goodpaster River is expected to result in only localized measurable impacts to less than 7 percent of the design stream flow and to provide a zone of passage constituting 78 percent of the wetted stream width. Therefore, it is expected that the discharge of treated domestic wastewater to the Goodpaster River would result in low to very low impacts.

Fuel Storage Location

Fuel storage at the construction camp below the 1525 Portal and at the airstrip would represent potential impacts to water quality from two primary sources: fuel spills and stormwater runoff. Stormwater runoff would be managed by using BMPs and is expected to have a negligible impact on water quality.

Temporary fuel storage for the development phase would include the existing eight 20,000-gallon fuel tanks at the construction camp previously used during exploration activities, and fifteen 20,000-gallon tanks to be erected at the airstrip. These tanks would be removed following the development phase. These fuel tanks would be located within a bermed and lined area with a volume greater than 110 percent of the largest individual tank. This secondary containment would decrease the potential for a fuel spill. The use of containment facilities for the fuel transfer operations would further minimize the potential for spills. Without mitigation, however, a fuel spill in this location would result in contamination of the alluvial aquifer, and seepage of contaminated ground water to the Goodpaster River also could occur. The impacts of a major spill could be high.

With proper use of spill containment facilities and the development of an SPCC plan by the Applicant prior to operation, the potential for a spill would be low, and if spills were to occur, they likely would be smaller. Therefore, overall, the impacts of temporary fuel storage at the construction camp and airstrip would be low.

Air Access 3,000-ft Airstrip in Goodpaster Valley

Use

- Pogo project only The use of the airstrip in the Goodpaster Valley is expected to have minimal impacts on water quality. The airstrip is projected to receive its greatest use during construction when the winter road would not be available and the all-season road were not yet completed. A potential concern is the occurrence of a fuel spill. A 5,000-gallon fuel tank containing Jet-A fuel would be located near the airstrip. Planned secondary containment at the fuel tank would reduce the risk of a release. The use of the airstrip by the Pogo project only would minimize the air traffic and potential fuel spills. Without mitigation, if a fuel spill were to occur, the ground water in the alluvial aquifer would likely be affected. Seepage of contaminated ground water to the Goodpaster River could also occur. The likelihood of a large spill is low, however, and full implementation of an SPCC plan would reduce the likelihood and severity of spills. Overall, the impacts are expected to be low.

- Pogo and other industrial/commercial users only With increased usage, there is the potential for increased risk of a spill if refueling were to occur at the airstrip. As with the use of the airstrip by the Pogo project only, however, the likelihood of large spills is low, and the severity of the spills would be reduced with mitigation.

- Everyone With structural source control BMPs in place and maintained by the Applicant, the option in which the airstrip would be open for use by all users is expected to have a low impact on water quality. The potential for spills under this option would be slightly greater than the previous two options because the airstrip could be used by members of the public, resulting in an increased volume of air traffic.

Disposition

- Remove and reclaim Removing and reclaiming the airstrip at the end of the project would eliminate the potential for fuel spills in the future and could have a potential positive effect on water quality. There would be potential short-term impacts from construction activities required to remove the airstrip. These impacts could include exposed sediments that could be eroded to the Goodpaster River, resulting in higher suspended solids loads. These impacts would be short term and could be mitigated by using silt fences and other sediment control practices and BMPs during construction. Revegetation would mitigate long-term erosional impacts. Overall impacts from this alternative would be positive because reclamation of the airstrip would remove the potential for fuel spills in the long term, and the short-term impacts would be low.

- Open for Industrial/commercial resource users Maintaining the airstrip for future industrial resource users would potentially increase the possibility of a fuel spill if refueling activities took place at the airstrip. If refueling activities were conducted in an uncontrolled environment without ongoing training or maintenance of BMPs, the potential for a spill would be increased. The impact to the Goodpaster River of a spill from this location could be high if the spill migrated through the alluvial aquifer to the river. If BMPs were maintained by industrial/commercial resource users, the potential for a release would be low. If no storage of fuels or refueling took place on the airstrip, the potential for impacts would be low.

- Open for everyone Maintaining the airstrip for all users would potentially increase the possibility of a fuel spill if refueling activities took place at the airstrip. If refueling activities were conducted in an uncontrolled environment without ongoing training or maintenance of BMPs, the potential for a spill could be moderate. The impacts to the Goodpaster River of a spill from this location could be high if the spill migrated through the alluvial aquifer to the river. The maintenance of BMPs would decrease the potential of a spill and would decrease the potential impact if a spill occurred. If no storage of fuels or refueling took place on the airstrip, the potential impacts would be low.

4.3.3 Options Not Related to Surface Access

Alternative 2

Tailings Liner Facility

- Unlined Dry Stack and RTP Same as discussed in Section 4.3.2.

Power Supply

- Power line Construction of the power line could result in small temporary impacts on water quality from the construction of access roads and trails. With proper management and mitigation measures, the overall impacts on water quality are expected to be low. During construction of power line access roads and trails in the Shaw Creek and Goodpaster River watersheds, disturbed surfaces could erode and increase sediment in runoff. Sediment runoff could cause increased suspended sediment in creeks. The increased sediment and turbidity levels would likely be low because of the relatively small amount of construction required. These impacts would be temporary and could be mitigated by the proper use of silt fences and other sediment control practices and BMPs during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term. The impacts of this option on water quality are expected to be low.

Water Discharge

Development Phase

- Underground injection wells As discussed in Section 4.2.3, the injected ground water would have the potential to surface in nearby sloughs. Therefore, impacts to both ground water and surface water need to be considered for this discharge. This discharge would be regulated by both NPDES and UIC permits. The discharge criteria would include drinking water standards (18 AAC 80), aquatic life criteria (18 AAC 70), and human health criteria (18 AAC 70).

  Water quality during the development phase was estimated to be similar to the estimate provided for the mine seepage water quality as presented in the previous underground mine section (Table 4.3-10). This estimate represents a conservative reasonable worst case.

  Mine seepage water would be treated in the HDS ferric coprecipitation/lime softening system and, if necessary, in a sulfide precipitation system that would remove metals and arsenic and lower TDS. Removal efficiencies for arsenic, metals, and TDS were estimated based on the performance of the current exploration adit treatment system, information from other mines, and water treatment literature data (Teck-Pogo Inc., 2002b, 2002f). No removal of chloride, sulfate, ammonia, nitrate, or cyanide was projected for the treatment system. A summary of treatment efficiencies used for estimating treated water quality is presented in Table 4.3-10.

Projected water quality for mine seepage after treatment but prior to well injection during the development phase is also presented in Table 4.3-10. The effluent concentration estimates for the water treatment plant are presented as dissolved. These estimated discharge concentrations are based on reasonable worst-case conditions; therefore, these are conservative concentrations. Also presented in this table are the expected discharge criteria based on the recently (June 26, 2003) adopted State of Alaska water quality standards (18 AAC 70). The State of Alaska would be responsible for permitting this discharge. These were developed as dissolved criteria.

It is expected that a site-specific criterion of 650 mg/L for TDS would be applied in consideration of the quality of the receiving water. The receiving water quality used for site-specific criterion for TDS and to calculate the discharge criteria for the hardness-dependent metals was based on the water quality expected in the sloughs, which would be the surface water that would first receive the discharge. It was assumed that the majority of the water in the sloughs would come from groundwater discharge, and therefore, that the sloughs would have a TDS and hardness similar to those parameters of the ground water in the area.

Table 4.3-10 Alternative 2, Development Phase Projected Water Quality to be Discharged to Injection Wells, and Expected Discharge Criteria

Parameter	Basis of Treatment Plant Effluent Concentration (Dissolved)	Estimated Treated Effluent (Dissolved)	Expected Discharge Criteria[2]	Units
TSS	Fixed at 20	20	30	mg/L
TDS	Equal to 85% of influent	552	650	mg/L
Cl	Equal to Influent[1]	5	250	mg/L
SO_4	Equal to Influent[1]	**283**	250	mg/L
NH_3 [4]	Equal to Influent[1]	**10**	5.9[3]	mg/L
TKN [4]	Equal to Influent[1]	10	10	mg/L
NO_3 [4]	Equal to Influent[1]	10	10	mg/L
CN_T	Equal to Influent	**20**	5.2	µg/L
As	Fixed at 30	30	50	µg/L
Cd	Fixed at 0.3	0.3	0.64	µg/L
Cr	Fixed at 30	30	231	µg/L
Cu	Fixed at 10	10	29	µg/L
Fe	Fixed at 300	300	1000	µg/L
Pb	Fixed at 1	1	11	µg/L
Hg	Fixed at 0.1	0.1	0.77	µg/L
Mn	Fixed at 50	50	50	µg/L
Ni	Fixed at 30	30	168	µg/L
Se	Equal to Influent[1]	2	4.6	µg/L
Ag	Fixed at 0.1	0.1	37	µg/L
Zn	Fixed at 15	15	382	µg/L

1 Treated effluent concentrations of these parameters are equivalent to the water quality estimates for the mine drainage; these parameters would not be effectively treated by using the HDS ferric coprecipitation system.
2 Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 400 mg/L.
3 Based on ammonia chronic criteria for temperature between 0 and 14ºC and pH of 7.
4 All forms of nitrogen in combination must not exceed 10mg/L.
Note: Parameter values that are estimated to exceed their water quality criterion in Table 4.3-10 and subsequent tables are shown in **bold**.

Based on this comparison using the dissolved concentrations, the water injected into the well would meet the discharge criteria for all parameters except sulfate, ammonia, and cyanide. Those parameter values that are estimated to exceed their water quality criterion in Table 4.3-10 and subsequent tables are shown in bold. As discussed in Section 4.3.2, the cyanide concentrations used in this estimate may be overstated. Lower concentrations in the discharge during the development phase may result in meeting the cyanide discharge criteria. Additionally, the estimated cyanide discharge concentration is based on a total cyanide analysis. The water quality standards are based on a WAD cyanide analysis. Total cyanide analyses include all forms of cyanide including strong metal-cyanide complexes, weak and moderately strong metal-cyanide complexes, and free cyanide. WAD cyanide includes all but the strong metal-cyanide complexes. WAD cyanide is expected to be lower than a total cyanide analysis, and, hence, the WAD cyanide concentrations are expected to be lower than presented in this table.

The sulfate value is slightly above the discharge criterion, hence, it is likely that the sulfate concentrations would exceed the criteria only occasionally. The reasonable worst-case ammonia concentration is estimated to be about twice the criteria (for the assumed temperature and pH). The frequency of ammonia exceeding the criteria would depend primarily on operational practices for selecting and using explosives in the mine; therefore, operational changes could be made to reduce the potential for exceeding the criteria. If the cyanide did not exceed or infrequently exceeded the criteria, the resulting concentrations would be considered to be a potentially moderate impact from a permitting and compliance perspective.

There may be some attenuation for certain parameters within the ground water. However, because of the potential for injected water to surface in a relatively short period of time, the degree of attenuation may be low. Therefore, there is the potential for the discharge to exceed the discharge criteria in nearby sloughs. In the portions of the Goodpaster River that receive input from either the ground water or sloughs, increases in concentrations in the Goodpaster may occur. The concentrations in the Goodpaster River are expected to be lower than the concentrations in the ground water or sloughs due to dilution. If the concentrations of the water that is discharging to the Goodpaster occasionally exceed water quality criteria, these occurrences would be considered a moderate impact. It is expected that if an exceedance of water quality criteria did occur, it would be localized to the Goodpaster River near the area of groundwater or slough discharge due to dilution in the Goodpaster River.

Operations Phase

Water treatment would occur at two treatment plants with a combined nominal capacity of 500 gpm, and a combined maximum capacity of 750 gpm. Water would be discharged either to the SAS or to an injection well. Water discharged during the operations phase of the project would include water from the mine and the RTP, as presented in the conceptual flow diagram and water balance shown in Figures 2.3-5 and 2.3-7, respectively. This water would be treated by HDS ferric coprecipitation/lime softening prior to discharge.

- Soil absorption system
  - Adjacent to airstrip The SAS was described in Section 2.3.10. The expected influent and effluent from the SAS are presented in Table 4.3-11. The effluent quality

presented in this table is the expected water quality just as it exits the SAS prior to contacting the underlying ground water. This water quality estimate was based on a series of column studies that evaluated the removal efficiency of water contaminants under different soil column conditions (Teck-Pogo Inc., 2000f).

Under the UIC requirements, the influent to the SAS would be required to meet drinking water standards and the effluent from the SAS would be required to meet the aquatic life and human health standards. The State of Alaska adopted dissolved water quality criteria June 26, 2003 (18 AAC 70). It is expected that EPA will approve these water quality criteria prior to issuance of the final NPDES permit. EPA requires that all permit effluent limitations be in “total recoverable” concentrations. Hence, two sets of criteria are presented in Table 4.4-11 and in subsequent tables. As presented in Table 4.3-11, the influent to the SAS is expected to achieve drinking water standards for the 95th percentile of the annual average for all parameters except nitrate, and is expected to exceed TDS, chloride, sulfate, total Kjeldahl nitrogen (TKN), and nitrate for the 95th percentile of the annual maximum.

The effluent from the SAS is expected to exceed the dissolved and total recoverable discharge criteria for the 95th percentile of the annual average for nitrate, cyanide, cadmium, copper, and lead. The 95^{th} percentile of the annual average also would exceed the total recoverable criteria for manganese. As discussed previously, the estimated cyanide concentrations are based on a total cyanide concentration and the criterion is based on a WAD analysis. Hence, the WAD cyanide concentrations are expected to be lower than what is presented in this table.

For the 95th percentile of the annual maximum, TDS, chloride, sulfate, nickel, and selenium would be exceeded for dissolved and total criteria in addition to those exceeded for the annual average. Manganese also would be exceeded for total criteria only. These additional parameters at the 95th percentile of the annual maximum would likely exceed the discharge criteria less frequently than for the 95th annual average. Because the influent to the SAS and the discharge from the SAS are estimated to exceed the expected discharge criteria for a number of parameters, this discharge was defined as having a high impact from a permitting and compliance perspective, and may not be permittable.

Although the regulatory compliance standards applicable to aquatic life and human health for this discharge likely would be the point at which the water is discharged from the SAS to the ground, additional analysis was conducted to determine the processes that would occur in the ground water.

Table 4.3-11 Alternative 2, Operations Phase Projected Water Quality of Influent and Effluent from Soil Adsorption System and Expected Discharge Criteria

	Influent to SAS		Effluent from SAS		Effluent from SAS		Expected Criteria		
Parameter	95% Annual Average Dissolved	95% Annual Maximum Dissolved	95% Annual Average Dissolved	95% Annual Maximum Dissolved	95% Annual Average Total	95% Annual Maximum Total	Water Quality Criteria - Dissolved	Permit Basis Criteria - Total Recoverable	Units
TSS	20	20	20	20	20	20	30	30	mg/L
TDS	433	**551**	433	**551**	433	**551**	500	500	mg/L
Cl	108	**251**	108	**251**	108	**251**	230	230	mg/L
SO_4	206	**272**	206	**272**	206	**272**	250	250	mg/L
NH_3[2]									
TKN	7.14	**10.24**	5.00	7.17	5.0	7.2	10	10	mg/L
NO_3	**14.4**	**17.7**	**14.4**	**17.7**	**14**	**18**	10	10	mg/L
CN_T	22.2	33.4	**15.5**	**23.4**	**16**	**23**	5.2	5.2	µg/L
As	30	30	18.0	18	21	21	50	50	µg/L
Cd	0.295	0.3	**0.30**	**0.3**	**0.34**	**0.34**	0.1	0.1	µg/L
Cr	9.11	13.1	5.47	7.86	6.4	9.1	29	29	µg/L
Cu	10	10	**9.50**	**9.5**	**10**	**10**	2.9	3	µg/L
Fe	300	300	225	225	703	703	1000	1000	µg/L
Pb	1	1	**1.0**	**1**	**1.6**	**1.6**	0.59	0.60	µg/L
Hg	0.1	0.1	0.1	0.1	0.12	0.12	0.77	0.77	µg/L
Mn	50	50	50.0	50	**56**	**56**	50	50	µg/L
Ni	23.9	30	14.3	**18**	15	**19**	17	17	µg/L
Se	5.62	8.79	3.37	**5.27**	4.4	**6.9**	4.6	5	µg/L
Ag	0.0914	0.1	0.09	0.1	0.23	0.26	0.4	0.4	µg/L
Zn	15	15	10.5	10.5	11	11	39	40	µg/L

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated using a hardness of 27 mg/L.
[2] Ammonia not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

Fate and transport modeling was conducted for the ground water downgradient of the SAS to determine concentrations of key constituents in ground water prior to reaching the Goodpaster River (Teck-Pogo Inc., 2002f). This modeling evaluated two different discharge flow rates to the SAS. These flows were the projected average flow of 144 gpm and the projected maximum flow rate of 365 gpm. The modeling indicated that, at the expected average discharge flow, only cyanide would be slightly above the criterion when it reached the Goodpaster River. For the maximum discharge rate, nitrate and iron would also be exceeded. The modeling results are uncertain because of the difficulty in modeling transient conditions stemming from sudden changes in river levels, which are known to occur and that would have a further dilutive effect on concentrations. Therefore, it is not certain that water quality criteria would be exceeded. With the attenuation and dilution expected in the ground water, and the probability of a wide zone of groundwater discharge of a diffuse nature, the increase in concentration for these parameters from this discharge to the Goodpaster River would likely be small.

Hence, this impact would be to the ground water in the vicinity of the SAS and downgradient of the SAS and potentially to the Goodpaster River where the ground water discharges to the river. If the concentrations of the ground water that discharged to the Goodpaster River exceeded water quality criteria frequently, the exceedances would be considered a high impact. It is expected that if an exceedance of water quality criteria did occur, it would be localized to the Goodpaster River near the area of groundwater discharge due to dilution in the Goodpaster River.

- ✦ Saddle above Pogo Ridge The expected influent and effluent from the SAS would be the same as presented in Table 4.3-11. The effluent quality shown in this table is the expected water quality just as the water exits from the SAS.

  The discharge criteria presented in this table assume that both NPDES and UIC permits are required and the SAS discharge would be required to meet both Water Quality Standards (18 AAC 70) and Drinking Water standards (18 AAC 80) as was required for the SAS in the Goodpaster Valley. The influent to and the effluent from the SAS would be expected to exceed the criteria for the same constituents as it would for the SAS in the Goodpaster River Valley.

  The water from the SAS would flow into the subsurface below the SAS into Easy Creek Valley. Some attenuation of the constituents in the water would occur as the water flowed through the colluvium or fractured bedrock. It is uncertain whether the flow would remain as subsurface flow or whether some surfacing of this discharge would occur.

- ▶ Underground injection wells In addition to the discharge to the SAS, Alternative 2 also includes the option to discharge treated water into up to three injection wells during operation. It is proposed that the injection wells would be used during the operations phase only under special circumstances, such as during rehabilitation of the SAS, discharge of clean RTP water, or mine drainage discharge, all of which would occur only when advanced sampling for potential contaminants had shown that the discharge could meet limits for injection well water quality.

Alternative 3

Tailings Facility Liner

- ✦ Lined Dry Stack and RTP The evaluation of seepage from the unlined surface dry stack and RTP (Sections 4.2.3 and 4.3.2) indicated that impacts from an unlined facility would be low. The addition of a liner would not substantially change the quantity of leakage or the impacts from the dry-stack seepage; hence, the impacts of this option would be the same as for Alternative 2.

Power Supply

- ▶ Power line Same as Alternative 2.

Water Discharge

Development Phase

- ▶ Direct discharge to Goodpaster Discharge of treated excess water during development would be directly to the Goodpaster River at a location 0.2 mile downstream from the exploration camp as shown on Figure 2.3-1a. This reach was selected as a discharge location because the river substrate is not suitable for fish spawning and, hence, would be a location where a mixing zone could potentially be applied. This river reach is adjacent to a large talus slope that appears to be a stable feature of the river based on historical aerial photographs (Teck-Pogo Inc., 2002d).

Mixing zone calculations were conducted (Teck-Pogo Inc., 2002d). A mixing zone could not be approved if there is the potential for mercury to bioaccumulate to high adverse levels [18 AAC 70.250 (a)(1)(A)]. It is uncertain whether mercury would bioaccumulate to high adverse levels from this discharge; hence, it is uncertain whether a mixing zone could be granted.

A minimum mixing ratio of 45 to 1 (total river flow to discharge flow ratio) was selected to provide sufficient mixing to meet both chronic water quality criteria at the edge of the mixing zone and acute water quality criteria at the point of discharge. The 45-to-1 total mixing ratio provides for a zone of passage for aquatic life that is greater than 50 percent of the river width. The mixing required within the mixing zone would be at a ratio of 25 to 1. (This ratio is for the river flow only within the mixing zone to the discharge flow.) The water would be discharged through a diffuser. The projected maximum discharge rate is 400 gpm. Actual flows would be varied, depending on the flow in the river. Discharges would not be made when the flow in the river was less then 10 cfs.

The size of the mixing zone was determined for the operations phase condition because the flows for that phase would be greater and the water quality would be lower than during the development phase. As a result, the size of the mixing zone would be larger for the operations phase. For the operations phase, it was conservatively assumed that mine inflows were at their peak, water consumption in the mill was zero (the mill was shut down), and the RTP was full at the beginning of the winter low-flow period. The analysis showed that a mixing zone extending 30 ft downstream from the outfall with a maximum width of 15 ft would provide adequate mixing (Teck-Pogo Inc., 2002d).

The projected water quality for the treated effluent and the quality at the edge of the mixing zone (25:1 dilution) during development are presented in Table 4.3-12. This water quality is based on a 25:1 ratio of river flow within the mixing zone to effluent flow. The discharge criteria included in this table used a hardness of 27 mg/L, which is a weighted average of the hardness in the river and the hardness of the discharge. 40 CFR 131.36 (c)(4)(ii) states “hardness values used shall be consistent with the design discharge conditions established for the flows and mixing zone.” The applicable water quality criteria presented in this table do not reflect the end-of-pipe water quality which would be achieved. The actual end-of-pipe effluent limitations would be back-calculated using the mixing zone and applicable discharge criteria as part of the NPDES discharge permit process. As previously described, two sets of criteria (dissolved and total recoverable) are presented. These represent the State of Alaska recently revised water quality criteria (dissolved) and the EPA criteria on which the NPDES permit would be based (total recoverable). The water quality at the edge of the mixing zone is projected to meet discharge criteria for all parameters.

Table 4.3-12 Alternative 3, Development Phase Projected Water Quality for Direct Discharge to Goodpaster River

Parameter	Estimated Treated Effluent (Dissolved)	Estimated Concentration at Edge of Mixing Zone (Dissolved)	Estimated Concentration at Edge of Mixing Zone (Total)	Water Quality Criteria - Dissolved	Permit Basis Criteria - Total Recoverable	Units
TSS	20	21.0	21	30	30	mg/L
TDS	552	117	117	500	500	mg/L
Cl	5	1.1	1.1	230	230	mg/L
SO_4	283	33.0	33.0	250	250	mg/L
NH_3	10	0.5	0.5			mg/L
TKN	10	1.0	1.0	10	10	mg/L
NO_3	10	0.4	0.4	10	10	mg/L
CN_T	20	0.8	0.8	5.2	5.2	µg/L
As	30	1.6	1.8	50	50	µg/L
Cd	0.3	0.04	0.04	0.1	0.1	µg/L
Cr	30	3.2	3.7	29	29	µg/L
Cu	10	1.8	2.0	2.9	3	µg/L
Fe	300	208	651	1000	1000	µg/L
Pb	1	0.26	0.41	0.59	0.60	µg/L
Hg	0.1	0.009	0.010	0.77	0.77	µg/L
Mn	50	23	26	50	50	µg/L
Ni	30	2.8	2.9	17	17	µg/L
Se	2	0.44	0.58	4.6	5	µg/L
Ag	0.1	0.008	0.019	0.4	0.4	µg/L
Zn	15	4.3	4.3	39	40	µg/L

1 Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 27 mg/L. End-of-pipe discharge criteria/limits would require back-calculation to account for in-stream mixing.
2 Based on ammonia chronic criteria for temperature between 0 and 14^{o} C and pH of 7.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

Operations Phase

- Direct discharge to Goodpaster The discharge of treated water would be the same as described for the development phase. Flow rates for the discharge during operation would vary between zero and 750 gpm, depending on the flow in the river. No discharge would occur when the flow in the river was less than 10 cfs.

  The water quality of this discharge is presented in Table 4.3-13. It is based on the projected water quality of the discharge of the HDS coprecipitation treatment plant. The water quality at the edge of the mixing zone is also based on a 25:1 mixing ratio. The possible discharge criteria are based upon the applicable water quality criteria and do not reflect the end-of-pipe water quality which would be required. The actual end-of-pipe effluent limitations would be back-calculated using the mixing zone and applicable discharge criteria as part of the NPDES discharge permit process. The water quality after mixing at this ratio is projected to meet discharge criteria for all parameters.

Table 4.3-13 Alternative 3, Operations Phase Projected Water Quality for Direct Discharge to Goodpaster River

	Direct Discharge to Goodpaster River from Water Treatment Plant		Concentrations in Goodpaster River at Edge of Mixing Zone		Concentrations in Goodpaster River at Edge of Mixing Zone		Expected Criteria		
Parameter	**95% Annual Average Dissolved**	**95% Annual Maximum Dissolved**	**95% Annual Average Dissolved**	**95% Annual Maximum Dissolved**	**95% Annual Average Total**	**95% Annual Maximum Total**	**Water Quality Criteria - Dissolved**	**Permit Basis Criteria Total Recoverable**	**Units**
TSS	20	20	21.0	21.0	21.0	21.0	30	30	mg/L
TDS	433	551	113	117	113	117	500	500	mg/L
Cl	108	251	5.0	10.5	5.0	10.5	230	230	mg/L
SO_4	206	272	30.0	32.6	30.0	32.6	250	250	mg/L
NH_3[2]									
TKN	7.14	10.2	0.9	1.0	0.9	1.0	10	10	mg/L
NO_3	14.4	17.7	0.6	0.7	0.6	0.7	10	10	mg/L
CN_T	22.2	33.4	0.9	1.3	0.9	1.3	5.2	5.2	µg/L
As	30	30	1.6	1.6	1.8	1.8	50	50	µg/L
Cd	0.295	0.3	0.04	0.04	0.04	0.04	0.12	0.13	µg/L
Cr	9.11	13.1	2.4	2.6	2.8	3.0	33	38	µg/L
Cu	10	10	1.8	1.8	2.0	2.0	3.8	4.0	µg/L
Fe	300	300	208	208	651	651	1000	1000	µg/L
Pb	1	1	0.26	0.26	0.41	0.41	0.84	0.90	µg/L
Hg	0.1	0.1	0.009	0.009	0.010	0.010	0.77	0.77	µg/L
Mn	50	50	23	23	26	26	50	50	µg/L
Ni	23.9	30	2.6	2.8	2.7	2.9	22	22	µg/L
Se	5.62	8.79	0.58	0.70	0.77	0.93	4.6	5	µg/L
Ag	0.0914	0.1	0.007	0.008	0.019	0.019	0.62	0.73	µg/L
Zn	15	15	4.3	4.3	4.3	4.3	51	52	µg/L

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 37 mg/L.
[2] Ammonia was not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

The water treatment plant would include advanced control systems providing for automated features that respond to changing conditions over short periods and for overall system modifications to meet potential future regulatory changes (i.e., lower arsenic standard) or unanticipated conditions. These contingencies would include flow-proportioned chemical feed systems and continuous pH, turbidity, and conductivity measurement and recording that reports to a computerized programmable logic controller (PLC). The PLC would generate operator alarms, activate alternative treatment or chemical feed, switch the plant to recycle, or initiate plant shutdown. These contingencies would minimize the occurrence of upset conditions. When upsets would occur, these contingencies would assist in detecting, recording, and adjusting for upsets to restore normal plant operations. In addition, the plant would be designed to allow for process changes if they become necessary as dictated by influent water quality and regulatory standards. Process changes could include addition of oxidants such as hydrogen peroxide to assist in arsenic removal, sulfide precipitation, and recarbonation.

Alternative 4

Tailings Facility Liner

- ✦ Lined dry Stack and RTP Same as Alternative 3.

Power Supply

- On-site generation Under this alternative, power would be generated on site. The largest potential concern for water quality would be the additional fuel that would need to be transported and stored for the project. The Applicant has estimated that an additional 4.2 million gallons of diesel fuel per year would need to be supplied to provide on-site power generation for the 2,500-tpd operation. This amount of fuel would be more than a five-fold increase in the fuel requirements for the power line option (786,000 gallons per year). The 4.2 million gallons per year would require an additional 525 tanker trucks (8,000 gallons each), for a total of 625 fuel trucks each year. The risk of a fuel spill would increase proportionally.

  The probability of truck accidents and release was reported as 1.9 x10^{-7} spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990). Based on this rate, the probability of a fuel spill with project power supplied by on-site power generation (and the need to haul fuel for generators) over the life of the project for 11 years of operation and a 49-mile route would be approximately 6 percent. This calculation only considered a one-way trip because the return trip from the mine would be with an empty truck. This frequency provides an order-of-magnitude estimate because the conditions on the Pogo mine road would be different from those for which the statistics were developed (more difficult driving and road conditions). This option would have a moderate to high potential to affect water quality. A fuel spill near a wetland could have a local impact. A major spill near a creek could result in a high impact over a large area of the watershed.

Water Discharge

Development Phase Same as operations phase below.

Operations Phase

- Off-river treatment works Effluent from the HDS water treatment plant would be disposed of in an off-river treatment works. This treatment works would consist of two ponds (Figure 2.4-2) (Teck-Pogo, Inc., 2002e). The ponds would be adjacent to the river just upstream of the proposed airstrip. Water would flow into the first pond by gravity. The intake channel in the river would be large and deep to allow water flow during winter icing conditions. A small pump station and wet well would be installed at the outlet of the first pond to transport water to the second pond. The inlet to the pump would be screened to prevent fish movement into the second treatment pond where aeration, precipitation, and settling processes would occur for some parameters, particularly iron. Water would be pumped from the first pond to the second pond at a rate that would provide the adequate mixing ratio. Pumping of river water would be monitored so that the flow in the river immediately downstream of the off-river treatment works intake channel would not fall below 20 cfs.

  Effluent from the water treatment plant would be mixed with the water pumped from the first pond in an in-line mixer and then discharged to the second pond. The second pond would provide additional retention time for mixing prior to the discharge from the pond to the river by gravity flow. The system would be designed to handle an average annual effluent flow rate of 154 gpm, with a maximum rate of 600 gpm from the water treatment plant and a 25-to-1 mixing ratio.

It is expected that efficient controlled mixing would be provided with the use of this effluent discharge option. The expected water quality in the effluent from the HDS water treatment plant is presented in Table 4.3-14. The water quality after mixing with Goodpaster River water at a 25-to-1 ratio is also shown in this table. Expected discharge criteria are presented. Criteria that are hardness based are calculated for a hardness of 27 mg/L, which is the estimated 5th percentile of the hardness of the water upstream of the discharge. This value was used because no mixing zone would be allowed at the proposed location, which is in a potential spawning area. As previously described, two sets of criteria (dissolved and total recoverable) are presented. These represent the State of Alaska recently revised water quality criteria (dissolved) and the EPA criteria on which the NPDES permit would be based (total recoverable). If upstream natural conditions measured concurrently with the discharge were higher than the criteria listed in Table 4.3-14, the discharge criteria would be the upstream natural conditions.

The discharge from the HDS treatment plant mixed with the Goodpaster River water at a 25-to-1 ratio is expected to meet all water discharge criteria. As shown in Table 4.3-14, the discharge meets criteria for all parameters for even the conservative 95th percentile of the annual maximum.

This option would not use river water for mixing when flows in the Goodpaster River were less than 20 cfs. This would affect the ability to discharge water and has an impact on the overall system water balance. If water discharges are limited during low flow conditions in the river, there is the potential that a higher volume of water would be carried through the winter in the RTP. This would result in less freeboard in the RTP for breakup flows. This effect is reflected in the Monte Carlo modeling which showed that the RTP would overtop more frequently for this option than for Alternative 2. Modeling showed the RTP would overtop and discharge without treatment approximately 45 times in 1,000 years during major storm or runoff events. This frequency, although still low, is approximately twice that for the SAS discharge system in Alternative 2. Note that the modeling conducted to determine this frequency of overtopping did not include use of supplemental groundwater from wells for dilution water in the mixing; therefore, this frequency is conservative.

The off-river treatment works would be expected to provide conditions for well-controlled mixing of effluent and river water, as well as favorable conditions for consistent monitoring. The treatment works would also have a benefit of having the mixing occur out of the Goodpaster River. In addition, at 400 gpm, residence time would be approximately 24 hours, which would provide ample time to respond to potential upset conditions at the water treatment plant by closing the shutoff valve in the outlet works of the second pond (Teck-Pogo Inc., 2002i). The system also would have the flexibility to increase water pumped from the first pond into the second pond to provide greater dilution prior to mixed water and effluent reaching the river.

Table 4.3-14 Alternative 4, Operations Phase Projected Water Quality to be Discharged to Off-River Treatment Works

	Discharge to Off-River Treatment Works from Water Treatment Plant		Discharge from Off-River Treatment Works to River		Discharge from Off-River Treatment Works to River				
Parameter	95% Annual Average Dissolved	95% Annual Maximum Dissolved	95% Annual Average Dissolved	95% Annual Maximum Dissolved	95% Annual Average Total	95% Annual Maximum Total	Water Quality Criteria - Dissolved	Permit Basis Criteria - Total Recoverable	Units
TSS	20	20	21.0	21.0	21.0	21.0	30	30	mg/L
TDS	433	551	113	117	113	117	500	500	mg/L
Cl	108	251	5.0	10.5	5.0	10.5	230	230	mg/L
SO_4	206	272	30.0	32.6	30.0	32.6	250	250	mg/L
NH_3[2]									
TKN	7.14	10.2	0.9	1.0	0.9	1.0	10	10	mg/L
NO_3	14.4	17.7	0.6	0.7	0.6	0.7	10	10	mg/L
CN_T	22.2	33.4	0.9	1.3	0.9	1.3	5.2	5.2	µg/L
As	30	30	1.6	1.6	1.8	1.8	50	50	µg/L
Cd	0.295	0.3	0.04	0.04	0.04	0.04	0.1	0.1	µg/L
Cr	9.11	13.1	2.4	2.6	2.8	3.0	29	29	µg/L
Cu	10	10	1.8	1.8	2.0	2.0	2.9	3	µg/L
Fe	300	300	208	208	651	651	1000	1000	µg/L
Pb	1	1	0.26	0.26	0.41	0.41	0.59	0.60	µg/L
Hg	0.1	0.1	0.009	0.009	0.010	0.010	0.77	0.77	µg/L
Mn	50	50	23	23	26	26	50	50	µg/L
Ni	23.9	30	2.6	2.8	2.7	2.9	17	17	µg/L
Se	5.62	8.79	0.58	0.70	0.77	0.93	4.6	5	µg/L
Ag	0.0914	0.1	0.007	0.008	0.019	0.019	0.4	0.4	µg/L
Zn	15	15	4.3	4.3	4.3	4.3	39	40	µg/L

[1] Discharge criteria for Cd, Cr, Cu, Pb, Ni, Ag, and Zn were calculated by using a hardness of 27 mg/L. Note that receiving water hardness value may change as additional site data is collected. See Appendix B of DEIS for draft NPDES permit that presents methodology.
[2] Ammonia was not estimated in Monte Carlo model.
Note: Parameter values that are estimated to exceed their water quality criterion are shown in **bold**.

4.3.4 Options Related to Surface Access

Alternative 2

Access

Route

- Shaw Creek Hillside all-season road The Shaw Creek Hillside all-season road would cross numerous tributaries to Shaw Creek and would bridge Rosa, Keystone, Caribou, Gilles, and Shaw creeks and the Goodpaster River. The potential water quality impacts for this option include:
  - Erosion and subsequent increased suspended solids during construction
  - Fuel spills during construction

- Runoff during operation
- Fuel or chemical spill during operation

With proper management and mitigation measures, the overall impacts on water quality are expected to be low during construction of the road. During construction in the Shaw Creek watershed, disturbed surfaces could erode and increase sediment loads in runoff. This could cause increased suspended sediment in Shaw Creek, the Goodpaster River, and their tributaries. The increased sediment and turbidity levels would be temporary and could be mitigated by erosion control BMPs, such as proper use of silt fences during construction. The appropriate specific erosion controls to be implemented may be determined by agency and company discussions. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

During road construction, there is also the potential for fuel spills. A fuel spill into Shaw Creek, Goodpaster River, or their tributaries could seriously affect water quality. The chances for a fuel spill could be greatly reduced by proper fuel management. By transferring fuel and refueling equipment only in designated areas with spill containment facilities, the potential for a fuel spill to affect water quality would be small.

After road construction was complete, the road would be used to transport supplies to the mine. Impacts to water quality could occur during this period from runoff from the road and larger spills of material transported. Runoff from the road would include suspended particulate material that could increase suspended solids and turbidity in the surface water bodies. Additionally, runoff from the road would carry any fluids that were leaked from vehicles onto the road, including antifreeze, oil, or other vehicle-related fluids. These runoff-related impacts are expected to be small.

There is also the potential for larger spills of fuel or chemicals to occur. The types and quantities of materials that would be transported to the site during operation are presented in Table 2.3-2. The materials include cement, fuel (primary diesel), explosives, and reagents for the mill. Mill reagents would include lime, sodium cyanide, sulfuric acid, and sodium metabisulfite. Based on the quantities listed in Table 2.3-2, the number of annual truck trips required for fuels and reagents to be used in quantities of greater than 500 tons per year was estimated. These estimates are presented in Table 4.3-15.

Table 4.3-15 Commodity Transport Frequency

Commodity	Quantity per Truck	Annual Number of Trucks
Fuel	8,000 gallons	100
Cement	27 tons	520
Lime	20 tons	50
Cyanide	20 tons	50
Sodium metabisulfite	20 tons	50
Sulfuric acid	20 tons	25

Based on these estimates, there would be approximately one truck each week transporting lime, cyanide, and sodium metabisulfite; approximately two tankers per week for fuel; and approximately 10 trucks per week transporting cement. Sulfuric acid would be transported at an average of one truckload every 2 weeks. A spill of any of these commodities would have the potential to affect surface water quality if the spill occurred near a wetland or a creek. A large spill of fuel or other liquid commodity would have the potential to affect ground water if it occurred at most locations along the route. Spills of some solid commodities (e.g., cement and lime) would have a somewhat lower potential for contaminating surface water or ground water. A direct spill into a surface water body (e.g., wetland or creek) would have the greatest impact.

The probability of truck accidents and releases was reported as 1.9 $x10^{-7}$ spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990). As an example, the probability of a fuel spill with project power supplied by power line (i.e., without need to haul fuel for on-site power generation) over the life of the project for 11 years of operation and a 49-mile route would be approximately 1 percent over the life of the project. This calculation only considered a one-way trip because the return trip from the mine is with an empty truck. This frequency provides an order-of-magnitude estimate because the conditions on the Pogo mine road would be different than those for which the statistics were developed (more difficult driving and road conditions). Cement, lime, cyanide, and sodium metabisulfide would have lower probabilities of spills because of the fewer number of trips. The probability of a cyanide release would likely be lower because of the secure shipping containers planned to be used to transport cyanide. Overall, the likelihood of a substantial release is expected to be low. However, the impact of a large spill into a surface water body would be high.

The potential for a spill would be mitigated by operational processes to improve the safety of travel on the road, including having all traffic in contact with Pogo security and each other while traveling on the road. The overall impact of commodity transport by this access route to water quality would be moderate.

The use of the existing Shaw Creek Road egress would not cause any additional potential impacts to water quality. The proposed Tenderfoot egress option would have minor additional impacts to water quality because construction of this new section of road would be required, but these impacts would be small and temporary.

Use

- Pogo project only The potential for accidents and subsequent spills would be minimized if road use were restricted to Pogo-related vehicles only. With lower levels of traffic on the road, drivers properly instructed, and no personal vehicles allowed on the road, this option would have the minimum potential for accidents, spills, and subsequent potential impact to water quality.

- Pogo and other industrial/commercial users only This option could have a somewhat higher volume of traffic from other exploration activities and industrial/commercial operations. If all such drivers were instructed on the procedures for driving on the access road, the risks of an accident and subsequent spill would be moderate. The risk of a spill would be higher than the Pogo-related use only option because of the higher volume of traffic.

- Use by everyone Opening the entire road to everyone during project operation would increase the potential for an accident with a subsequent potential for a spill and an impact to water quality. With drivers on the road who have not gone through specific instructions for driving the road and the higher traffic volume, the risk of an accident with a truck carrying commodities to the mine (fuel or mill reagents) would increase. The risk of an impact to water quality would be moderate.

- ✦ Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except those impacts would only occur in the lower two-thirds of Shaw Creek Valley.

Disposition

- Remove and reclaim Removal and reclamation of the all-season road at the end of the project would eliminate the potential for spills from road traffic and would have a potential positive effect on water quality. There would be potential short-term impacts from construction activities required to remove the road. These impacts could include exposed sediments that could be eroded to Shaw Creek and its tributaries and to Goodpaster River, resulting in higher suspended solids loads. These impacts would be short term and could be mitigated by using silt fences, other controls to provide protection from sediment erosion, and BMPs. Revegetation would limit long-term erosion issues. Overall impacts from this alternative would be positive because of the removal of the access road, and the impacts would be short-term.

- Leave open for industrial/commercial users Use of the road by industrial/commercial users would have a higher potential for accidents and spills of commodities that could cause an impact to water quality. The types and quantities of materials transported under this option and the degree of maintenance that the road would receive after the closure of the Pogo project would affect the potential impacts to water quality. If a substantial amount of commercial traffic were maintained carrying commodities similar to the type during the Pogo project operation, the impacts would be moderate.

  - ✦ Leave open to everyone Unrestricted use of the road after mine closure would have the highest potential for accidents and spills of commodities that could cause an impact to water quality. With drivers on the road who have not gone through specific instructions for driving the road and the higher traffic volume, the risk of an accident with a truck carrying commodities to a mine (fuel or mill reagents) would increase. The risk of an impact to water quality would be in the moderate range.

  - ✦ Reclaim past Gilles Creek This option would have the same impacts described above for the option of leaving the road open to everyone, except those impacts would only occur in the lower two-thirds of Shaw Creek Valley.

Power Line Route

Impacts from the Shaw Creek Hillside power line route are expected to be low and would be the same as described for the Alternative 2 power line option in Section 4.3.2.

Alternative 3

Access

Route

- South Ridge all-season road The South Ridge all-season road would have the potential for impacts similar to those described for the Shaw Creek hillside route. The potential for erosion from construction activities, however, would be more severe given the greater steepness of the road profile and more difficult soil conditions (Teck-Pogo, Inc. 2000b). The potential for accidents and spills would be moderate because of the more exposed conditions, ice, higher winds, and greater potential for whiteout conditions in the winter. The potential for an individual spill to affect a water body would be lower because of the distance of the road from active drainages during the ridge portion of the route. This option would have a moderate potential to affect water quality through spills into drainages over the life of the project.

Use Same as Alternative 2.

Disposition Same as Alternative 2.

Power Line Route Same as Alternative 2.

Alternative 4

Access

Route

- Shaw Creek Flats winter-only access Construction-related impacts to water quality on the winter-only access route in Shaw Creek Valley are expected to be relatively minor and short term. Road construction in the section between the Shaw Creek and Goodpaster River valleys would be the same as for the all-season road. At the end of each winter, when the ice that formed on the road melts, any leaks or small spills that occurred on the road surface would enter nearby surface water. Contaminants contained in the winter road would include fluids that could potentially leak from vehicles, including oil, antifreeze, and fuel. The larger spills could be removed prior to breakup to mitigate these releases. The impact of a release is expected to be minor.

  In this option, all surface transportation of materials would occur annually during an approximately 8-week window. It is estimated that 35 trucks per day traveling in convoys 7 days per week, 24 hours per day, would be required to transport fuel and supplies to the mine for the entire year. The conditions during this transportation period would likely be very difficult. A large portion of the transport would be done during the dark, with a high potential for adverse weather conditions. The potential for an accident and subsequent spill would be considerably higher, given these travel conditions; therefore, this option would have a potentially high impact on water quality. For example, a large fuel spill near a tributary to Shaw Creek could result in a high impact to water quality in the tributary and to a substantial portion of Shaw Creek. Some spill cleanup could occur, but with ice or partial ice cover on the tributary or creek, spill containment would be difficult.

  - Traditional winter road construction standards Road construction on most portions of the Shaw Creek Flats winter-only access route would not have an impact on water quality because no excavation or soil disturbance would occur.

  - Perennial winter trail construction standards This sub-option would be similar to the traditional winter road except the trail surface would be bladed flat and would require small cuts and fills and limited removal of some surface organics. This road preparation would initially contribute to an increase in erosion and increase in suspended solids in the surface water bodies adjacent to the road. These impacts would be relatively minor and of short duration if properly managed with the use of sediment controls and revegetation. Because some construction activities would occur in the winter, controls would need to be in place the following spring to prevent erosion.

The potential for accidents and subsequent spills would be slightly lower for this option than for the traditional winter road. This reduced potential for accidents results because the window of availability for the perennial winter trail would be approximately 2 weeks longer than the traditional winter road, which would result in a somewhat lower number of daily truck trips. This option, however, would also have a high potential to affect water quality.

4.3.5 Cumulative Impacts

- All-season Road Reclaimed   Absence of an all-season road would limit other resource development activities and human use, and would result in no or low cumulative impacts to water quality.

- All-season Road Maintained   An extended mine life for the Pogo project itself would have little effect on water quality because there likely would be a relatively small increase in surface disturbance, and because the existing water treatment and discharge system likely would continue to be used.

  The construction of two hypothetical mines in the Goodpaster River Valley would have potential impacts on water quality in the following areas:

  - Roads to the new mines that would increase road construction and truck traffic
  - Additional discharges of excess mine water

  Extension of the Pogo project road from the Pogo mine to the hypothetical Sonora and Slate Creek mines would result in water quality impacts. During road construction in the Goodpaster River watershed, disturbed surfaces could erode and increase sediment in runoff. This could cause increased suspended sediment in the Goodpaster River. The increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of silt fences and other BMPs during construction. Revegetation of disturbed areas after construction would help diminish sediment release to the creeks in the long term.

  Additional truck traffic would contribute to a greater risk of accidents, spills, and subsequent releases to surface water and ground water. If these additional mines were of similar size to Pogo, the truck traffic would increase several-fold. Additionally, the transport of ore from the hypothetical Sonora Creek mine to the Pogo mill would add a potential for a spill of the ore into a water body. The initial impact of such a spill would be primarily an increase in suspended solids of the water body. With time, sulfide minerals could oxidize if they were not removed from the water body. Removal of the spilled ore could be accomplished, but that action would also lead to an additional short-term increase in suspended solids.

  Discharges of excess water from the hypothetical Sonora Creek and Slate Creek mines are assumed to be similar to those expected from the Pogo mine. Treatment of the effluent from these sources would result in a water quality similar to that of water to be discharged from Pogo. Slight increases in concentrations of a few parameters would be likely, including chloride and sulfate, but the differences would be difficult to detect under most flow conditions. In summary, the cumulative impacts of additional mines in compliance with the proper permits would be low.

4.4 Air Quality

The National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) presented in Table 3.8-1 set primary and secondary standards for air pollutants. The primary ambient air quality standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health. The secondary ambient air quality standards define levels of air quality that are necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant [40 CFR 50.2(b)]. Public welfare includes impacts on flora, fauna, and soils. The air quality permitting processes are designed to ensure that projects meet these standards. Therefore, a project operating under the terms of an air quality permit is considered to have no major impacts on air quality.

4.4.1 No Action Alternative

The No Action Alternative would have very low air quality impacts, and would not affect the ability of other potential projects in the area to be permitted because of air quality concerns. Although there would be minute impacts in the general area as a result of long-range transport of air pollutants from any developed project, the distances between projects would be such that air quality aspects of any one project would not affect the ability of any of the other projects to be permitted.

Overall, the impacts on project area air quality from the No Action Alternative would be minimal.

4.4.2 Options Common to All Alternatives

The options common to all alternatives would have low and insubstantial impacts on long-term air quality. Through the construction permit process for air quality, all action alternatives would be required to demonstrate compliance with AAAQS, which meet or exceed the NAAQS. Compliance with these standards is considered adequate to protect the public welfare, and would be ensured by conditions developed in the operating permit process. The results of preliminary modeling conducted with and without on-site generation indicated that all alternatives could meet air quality permitting requirements (Hoefler Consulting Group, 2002).

The construction and operating permit processes would address the release of regulated air pollutants from all stationary sources as well as fugitive dust from operations associated with the project. Stationary sources would include the milling process and camp operations, and fugitive dust sources would include tailings disposal, development rock disposal, and the gravel production. Mobile sources, including vehicles, aircraft, and transportable equipment, are regulated at a national level through manufacturing regulations.

Construction of the project potentially would result in short-term, localized impacts on soils, vegetation, and visibility in the immediate area as a result of fugitive dust. In addition, operation of construction equipment and construction camp generators would result in products of combustion being released to the atmosphere. Although short-term construction impacts are not specifically addressed in the permitting process and there are no specific thresholds for fugitive dust, general air quality regulations require that reasonable precautions be taken to prevent particulate matter from being emitted to the ambient air during construction [18 AAC 50,045(d)]. In addition, emissions from construction equipment and generators are regulated on a national level by manufacturing regulations. As a result, only low and insubstantial impacts on air quality would occur during construction.

Although the options common to all alternatives would have low or insubstantial impacts on air quality, some sub-options would have less impact on the environment than others. Sub-options that limit the use of the airstrip would have less impact on air quality than the sub-options that allow more use of this component. Similarly, removal of the airstrip at the end of the Pogo project would limit the duration of the impact on air quality compared to continued use of the airstrip.

4.4.3 Options Not Related to Surface Access

Because the Pogo Mine site is located more than 200 kilometers (125 miles) from any Class I area, none of the alternatives would require an analysis of impacts on a Class I area. In addition, construction and operation of any alternative are not anticipated to have an impact on any Class I area.

Alternative 2

Power Supply

- Power line This alternative would not have an impact on local air quality. It would, however, have low impact in the vicinity of the power generation source, but that source is currently operating under an existing air quality permit.

  At 2,500 tpd, the Pogo project would use approximately 10 MW of power, with up to 14 MW used for the 3,500-tpd scenario. GVEA's available capacity is approximately 90 MW (Ballistic Missile Defense Organization, 2000), with an additional 60-MW projected to be installed by the end of 2004. Thus, there would be ample power available for the proposed project under this alternative.

Alternative 3

Power Supply

- Power line Same as Alternative 2.

Alternative 4

Power Supply

- On-site Generation Preliminary modeling of project emissions with and without on-site power generation was conducted (Hoefler Consulting Group, 2002). Results show very little difference in impacts between the two power supply options. Results of the preliminary modeling indicated both power options could meet air quality permitting requirements and the on-site power generation option would have a low impact on local air quality.

4.4.4 Options Related to Surface Access

All access-related options would have low or insubstantial impacts on air quality. Generation of fugitive dust from use of gravel roads and the airstrip, however, would have a small effect on adjacent vegetation. The Shaw Creek Flats winter-only access option would have fewer fugitive dust impacts than use of the full-length all-season road. In addition, the sub-options limiting use of the all-season road to just Pogo project traffic would have less impact on air quality than the sub-options that would allow increased use of this component by other users. Similarly, removal of the all-season road at the end of the Pogo project would limit the duration of fugitive dust impacts on air quality in comparison to continued use of the road.

4.4.5 Cumulative Impacts

- All-season Road Reclaimed Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts on air quality other than those of fugitive dust associated with road reclamation.
- All-season Road Maintained Only very low cumulative impacts on air quality would occur from development associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines.

  Although there would be minute impacts in the general area of any other developed project as a result of long-range transport of air pollutants, the distances between projects likely would be such that air quality emissions of any one project would not affect the ability of any other projects to be permitted. The permitting processes are used to ensure that cumulative impacts of new as well as existing projects do not result in exceeding the NAAQS and AAAQS.

  The construction and use of new access roads to the hypothetical Sonora Creek and Slate Creek mines would generate additional fugitive dust during construction and operation of the roads themselves as well as other facilities associated with these hypothetical projects. Fugitive dust also would be generated by an airstrip associated with a new Slate Creek mine. Such fugitive dust impacts would be small and limited to the local area.

  Overall, air quality cumulative impacts from maintaining the all-season road would be very low.

4.5 Noise

Noise impacts were considered in the context of meeting the noise impact criteria for the Pogo Mine project. These impacts were primarily considered for human noise-sensitive receivers. These receivers include permanent residences, such as those along Shaw Creek Road, and areas that people frequent such as the Quartz Lake Recreation Area. The noise criteria used were derived from the EPA noise guidelines for residential areas and from FHWA traffic noise abatement criteria. The criteria were described in Section 3.9.3 (Noise and Vibration Criteria). These noise guidelines and regulations provide specific, measurable criteria by which noise impacts related to a project can be determined, and they were used in this analysis as the basis for determining the degree of noise impacts. General information on reference noise levels for equipment, noise level predictions, and impact projection methods is provided. Noise impacts on animals also are discussed.

4.5.1 No Action Alternative

Dominant noise sources would continue to include local fixed-wing aircraft and helicopter overflights, existing mining and exploration operations, local area snow machines and ATVs (both recreational and local access use), aircraft overflights from USAF training missions, and heavy truck traffic on the Richardson Highway. Other less noticeable noise sources that would continue under this alternative include passenger vehicle traffic and miscellaneous residential, recreational, and commercial activities, including chain saws, generators, and occasional small weapons firing.

Proposed projects that could have an effect on the existing noise environment include construction and operation of the NMDS and construction of a natural gas pipeline, as well as other smaller industrial and commercial activities, such as mining exploration, timber harvesting, and quarry activities. Actual changes in the area's noise levels would vary by project type, location of noise-sensitive receivers, and the type of equipment necessary for the project to be developed.

Overall, no major changes in project area noise levels were projected from the No Action Alternative.

4.5.2 Options Common to All Alternatives

There are several primary noise-producing components of mining projects. The three main noise components for the Pogo Mine project would be general mining activities (those activities related to ore retrieval and processing), aircraft flights of supplies and personnel, and mining-related traffic on the mine access routes and along the Richardson Highway. Of these three components, only the general mining activities were expected to produce essentially the same noise level regardless of the alternative selected. The noise levels produced by aircraft and vehicle traffic would vary depending on the type of access, the route, and the design options.

Because of the differences in potential noise levels resulting from the project's various noise sources, several independent models for noise prediction were used in this analysis. The individual noise levels were then summed, logarithmically, to determine the overall noise level for each alternative. The following subsection describes the modeling methods and the general results of the calculations.

Calculations of Mine Area Noise Levels Given the existing moderately high level of air traffic in the project area, the limited number of flights that might occur during as well as after mine closure under any use and disposition option, and the limited number of sensitive receivers in the vicinity, changes in noise levels were not projected to be noticeable. Thus, no major differences in noise levels were projected under any of the airstrip use and disposition options.

Noise level projections for operational mine areas were made by using the methods described in EPA (1971b), as well as with information from other acoustical sources related to the type of potential noise-producing activities expected for this project. Reference noise levels for equipment were taken from measured noise levels of equipment in use at actual construction sites or mining operations, and from EPA and FHWA sources. Table 4.5-1 provides some reference noise levels for mining and construction equipment that could be used during construction and operation of the mine. For a sound level perspective, refer to Table 3.9-1.

Noise levels were expected to be the highest during initial construction of the mine site and support facilities. Once construction was completed, and most of the noisiest equipment were moved underground, noise levels for aboveground mine operations would be dominated by haul trucks, maintenance facilities, and other mine-related ancillary facilities.

For the purpose of determining the project noise levels and potential noise impacts, a general "distance versus sound level" table and graph were derived for general activities during construction and operation of the mine. An additional "sound level versus distance" table and graph also were developed for mine traffic on the different access routes. The simple tables and graphs of noise levels do not assume any additional noise reduction from topographical shielding or foliage, and can therefore be considered the “worst case” noise levels that could be produced from the mine and haul routes.

Table 4.5-1 Reference Mining and Construction Equipment Noise Levels

Description[1]	Hourly Use (Minutes[2])	Sound Level[3]
Haul trucks, CAT 78X, Dresser 685 or equivalent	45 – 60	72 – 88
Material handlers, Hitachi 3500 or equivalent	45 – 60	84 – 88
Motor graders, CAT 24H or 16H or equivalent	20 – 40	78 – 82
Dozer, Cat D10/11 or equivalent	20 – 40	88 – 92
Loader, Cat 988 or equivalent	20 – 40	84 – 88
Backhoe, CAT 325 or equivalent	20 – 40	76 – 80
Rock drill, IR-DM-M2, TEI jumbo or equivalent	10 – 15	90 – 92
Compactor	45 – 60	86 – 88
Light-duty trucks, service trucks, compressors, pumps, light plants, and other small engine powered equipment	45 – 60	65 – 81[4]

1 Normal equipment used for mining operations like those proposed for the Pogo project.
2 Average use per hour during normal mining activities.
3 Range of noise levels under normal operation as measured at a distance of 50 ft. For haul trucks, both the idle and nominal maximum operational noise levels are provided.
4 Assumes a mixture of compressors, light plants, small engine-powered generators, welders, and other operational and maintenance equipments. This mixture would be a minimal component of sound under normal operation, and was not expected to result in major changes in the overall noise levels.

For Pogo Mine construction and operations, two separate calculations were performed, one representative of the summer months and another for the winter months. The two calculations were performed to account for the more efficient sound propagation in cold air during winter months.

The winter calculations are representative of the operational noise levels that may be experienced at distances greater than 500 ft from the mine site during periods when temperatures are below 20ºF. The calculations assume soft ground cover, such as snow, and do not provide for actual noise reductions from area topography.

The summertime calculations were similar to the winter noise level calculations, but assume a higher temperature and slightly softer ground cover. These levels would be typical during summer months when temperatures are more moderate and ground cover consists of field grass or other foliage. Again, a direct line of sight between the receiver and the mine is assumed in the calculations. Figure 4.5-1 presents typical mine-related levels of construction noise. Figure 4.5-2 presents typical mine-related levels of operational noise after most noise-producing equipment would be moved underground. Each figure shows the two temperature and ground cover scenarios used to perform the noise calculations.

Figure 4.5-1 Typical Mine Construction Noise Levels

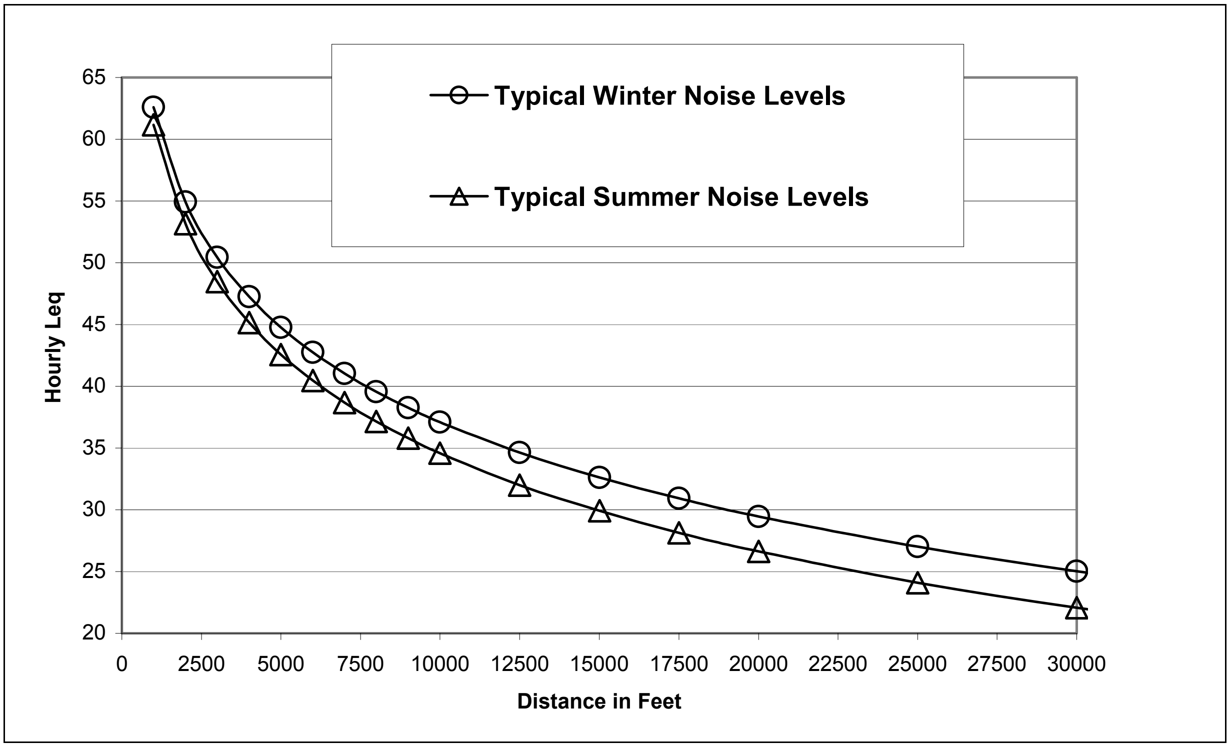
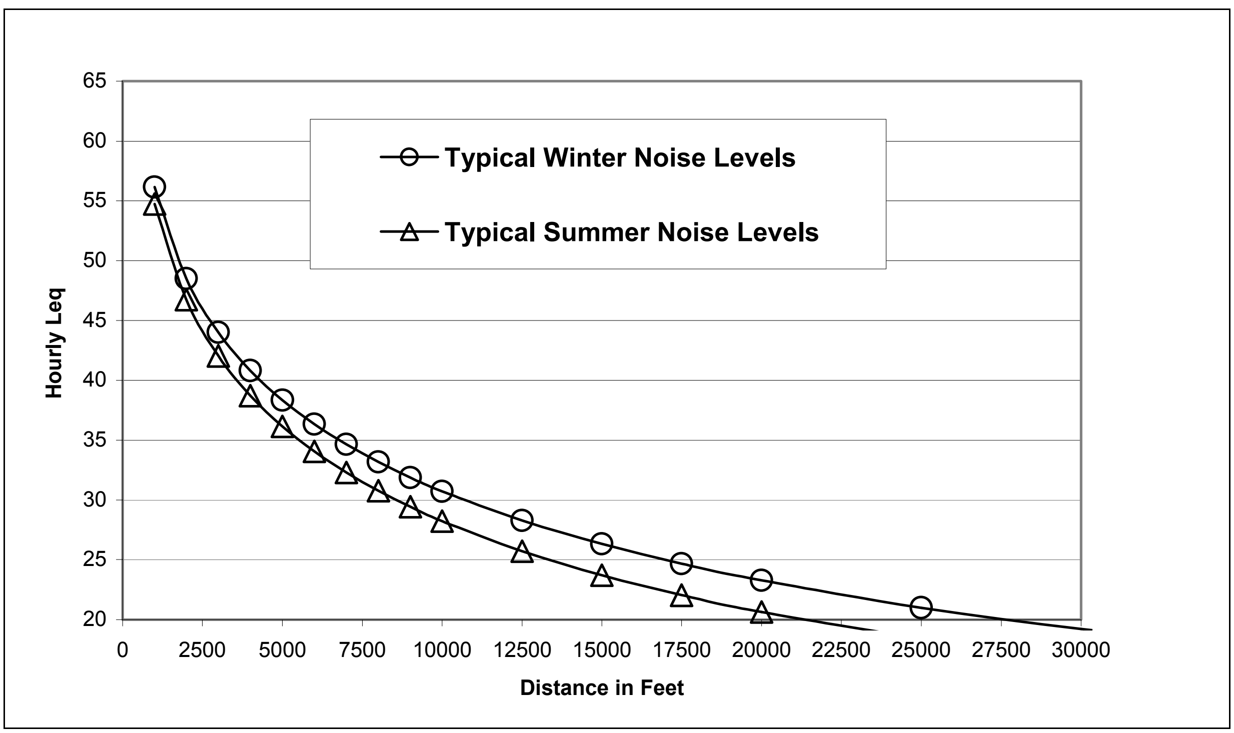


Figure 4.5-2 Typical Mine Operational Noise Levels



For noise-sensitive receivers located in the vicinity of Shaw Creek Road, Quartz Lake, Big Delta, and Delta Junction, noise from general construction or operations at the mine was not projected to cause any change over the existing noise environment. All these locations are a long distance from the mine site, and with the additional topographical reductions, noise levels from mine construction and operations were projected to remain below 25 dBA L_{eq}. There may be times, however, when atmospheric conditions make some noise from mine activities audible at certain locations. Even under extreme conditions, however, no high noise impacts were projected.

During initial construction, noise levels on the nearby Goodpaster River, between Pogo and Liese creeks, were projected to range from 30 to 40 dBA. Mine operational noise levels in the same area were projected to range from 25 to 35 dBA. Because this area has low human use, and visitors use motorized vehicles such as ATVs and outboard motors in the summer and snow machines in the winter, no high noise impacts were projected.

In addition to the general mining equipment noise, noise from blasting also was investigated for potential noise impacts. Because the distances to noise-sensitive human receivers would be in excess of 15 miles, blasting noise was not projected to result in a change in the existing noise environment at any noise-sensitive locations. Thus, no high blasting-related noise impacts were projected during construction or operation of the Pogo Mine.

Noise levels due to construction and operation of the mine were not expected to have high adverse effects on local wildlife. Loud noises from short-term events, such as blasting, is known to startle nearby wildlife and cause birds to "flutter," but wildlife normally return to their usual lifestyles shortly after such an event (Holthuijzen, 1989). Wildlife tend to habituate to noise from steady-state sources, such as trucks and generators, and such noise alone generally does not result in major changes in normal wildlife patterns. As a complement to other project-related human activities, however, such noise would contribute to wildlife avoidance of the mine site and access route vicinities.

No vibration impacts were projected under any of the alternatives because the distances between the mine, potential haul routes, and vibration-sensitive receivers are sufficiently large that vibration levels were not projected to be noticeable.

As at any remote industrial project site, construction and operations workers would be exposed to varying levels of noise, both during their shift work and during their off hours because they would live in on-site quarters. The mill and other mine area facilities would be designed and operated to reduce noise propagation and to insulate workers from noise. All mine area facilities would be required to meet strict MSHA noise standards designed to limit the levels of noise and periods of time to which mine workers may be exposed.

Air Access

Construction Air Traffic During initial construction, the mine site airstrip would support operations during the period when Goodpaster Winter Trail access would not be available and the permanent all-season access road not yet completed. Depending on when appropriate permits were received, this period could range from 6 to 12 months.

During this period, there would be between approximately 55 and 70 round trip flights per week, or 8 to 10 flights per day, to the mine area airstrip. These would include Twin Otter, Cessna Caravan, Cessna 206 and 207, DC-3, C-26, Caribou, and SkyVan aircraft. Heavy-lift helicopters also might be used to transport time-sensitive items that could not be transported by fixed-wing aircraft.

Although there is a moderately high level of existing air traffic in the area, the additional Pogo air traffic during construction could result in a high level of impact if flight paths were to be located over groups of cabins on the lower Goodpaster River. Modification of flight paths could substantially reduce such noise impacts.

Airstrip Use and Disposition Given the existing moderately high level of air traffic in the project area, the limited number of flights that might occur during mine operations as well as after mine closure under any use and disposition option, and the limited number of sensitive receivers in the vicinity, the changes in noise levels were not projected to be noticeable. Thus, no major differences in noise levels were projected under any of the airstrip use and disposition options.

4.5.3 Options Not Related to Surface Access

Alternative 2

Same as described in Section 4.5.2.

Alternative 3

Same as Alternative 2.

Alternative 4

Power Supply

- On-site Generation Same as Alternative 2, except there would be a mine site power plant. Because generators would use sound-reducing equipment, however, on-site power generation was not projected to result in a major change in the noise levels projected for general mining operations as described in Section 4.5.2.

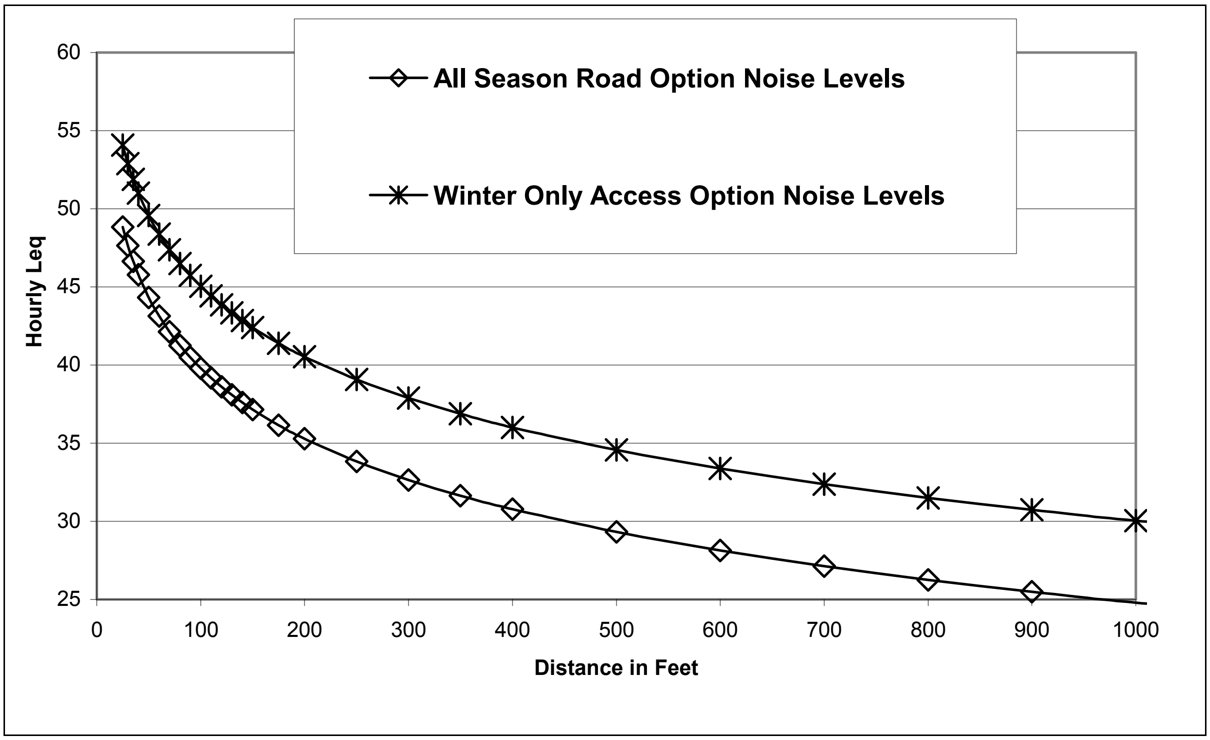
4.5.4 Options Related to Surface Access

To provide information on noise levels related to the access routes under consideration, detailed modeling was performed for traffic noise levels related to the access options. The analysis assumed a generic, "worst-case" scenario of vehicles accessing the mine site under all-season road and winter-only access options. Calculation methods and results are discussed below, with an impact analysis provided separately for each access option.

Calculations of access road traffic noise levels As with the calculations of operational noise levels, calculations of access road traffic noise assumed a direct line of sight to the roadway, and did not assume any topographical shielding or reduction due to foliage. Figure 4.5-3 presents projected noise levels for the access route under all-season road and winter-only access options assuming a speed of 35 mph. For a sound level perspective, refer to Table 3.9-1.

For the all-season road option, the average nominal Pogo-related traffic to and from the mine was assumed to be one heavy truck, one medium truck, and two cars per hour. For the winter-only access option, traffic was assumed to be three heavy trucks, two medium trucks, and two cars per-hour. Figure 4.5-3, presents the projected maximum hourly noise levels for the all-season road and winter-only access options assuming a speed of 35 mph. As shown in Figure 4.5-3, the winter-only access option was projected to produce noise levels that would be approximately 5 dBA higher than those projected for the all-season road option. These higher noise levels would be due to the more intense traffic use over a shorter time period for the winter-only access (30 to 35 trucks per day versus 5 to 7). The noise levels presented in Figure 4.5-3 can be considered worst-case, and actual noise levels might be 3 to 7 dBA lower due to shielding from area topography.

Figure 4.5-3 Projected Maximum Hourly Noise Levels for the All-Season Road and Winter-Only Access Options



Alternative 2

Surface Access

Route Under this alternative, mine site surface access would be provided with use of the Shaw Creek Hillside all-season road, with egress from the Richardson Highway provided either by the Shaw Creek Road/Rosa sub-option or by a new Tenderfoot egress sub-option.

- Shaw Creek Road/Rosa egress Seven residential structures were identified close to the existing Shaw Creek Road between the Richardson Highway and the beginning of a new Hillside all-season road (Ridder, 2001). The residences were numbered from 1 to 7, beginning at the Richardson Highway and moving toward the end of the existing road. This information was used to project traffic noise levels at each of the seven residences. The average nominal Pogo-related traffic on the all-season road to and from the mine was assumed as used above for Figure 4.5-3: one heavy truck, two medium trucks, and two cars per hour. The noise from this traffic was added to the existing background noise levels. The results of these traffic noise projections are shown in Table 4.5-2.

Table 4.5-2 Pogo-Related Traffic Noise at Residences Located Near Shaw Creek Road

Receiver #[1]	(Name)	~ Distance to Shaw Creek Road[2]	Shielding[3]	Existing Noise[4]	Projected Total Noise[5]	Projected Increase in Noise[6]
R1	(Harrild)	300	No	42	42	0
R2	(Newman-1)	350	Some	35	36	+1
R3	(Newman-2)	100	No	32	39	**+7**
R4	(Teck-Pogo Inc.)	40	No	32	44	**+12**
R5	(Naegele)	240	No	32	36	+4
R6	(Thorn)	200	No	32	36	+4
R7	(McNabb)	910	No	32	33	+1

1 Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
2 Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
3 All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
4 Estimated existing noise level from measurements in similar areas.
5 Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
6 Values in **bold** font indicate moderate or greater impact.

Between a moderate and high traffic noise impact was identified at receiver R4 due to the closeness (40 ft) of the residence to Shaw Creek Road. The future projected noise level of 44 dBA at this location represents a major increase in noise levels (12 dBA). This absolute noise level, however, usually is not considered a high level in most areas because it is the equivalent of a quiet rural residential area with no activity (Table 3.9-1). Thus, under the noise criteria described in Section 3.9.3 (Noise and Vibration Criteria), although the R4 receiver would experience a sizeable (greater than 10 dBA) *change* in noise levels, it would not be a high impact because the absolute level would be only approximately 44 dBA, well below the 50-dBA criterion for a high impact.

Increases in traffic noise levels of 4 dBA or greater also were identified at receiver locations R3, R5, and R6. Noise levels at these three receivers were projected to increase above existing levels by 4 to 7 dBA, resulting in total noise levels of 39 dBA at R3 and 36 dBA at R5 and R6. These noise levels would be equivalent to a bedroom or quiet living room (Table 3.9-1). Under the noise criteria described in Section 3.9.3 (Noise and Vibration Criteria), these increases were considered moderate. For reference, an increase of 3 dBA is generally considered barely perceptible by an average human ear, and increases of approximately 5 dBA are normally noticeable to most humans. The other five receivers in the vicinity of Shaw Creek Road were projected to experience increases of 4 dBA or less, which were considered a low impact.

Although the modeled results described above do not indicate high impacts under the common noise criteria used for this analysis, that does not mean residents would not be aware of the increased noise levels. The increase would represent a definite change for some residents from the relative isolation they now enjoy.

Shift-change traffic ─ TAPS crossing bus station The Applicant proposes to locate an employee parking area and bus station approximately 2.4 miles from the end of the existing Shaw Creek Road and approximately 750 ft southwest of the TAPS crossing (Figure 2.4-4). Employees would leave personal vehicles in a fenced, secured area, and would be transported to and from the mine by buses. Shift changes would occur every 4 days, and could be at any time of the day or night. Because of the distance to the mine site, it would take approximately 4 hours from the time buses left the TAPS crossing parking area/bus station with the incoming shift until the buses returned to the parking area/bus station with the outgoing shift. Thus, there would be two approximately one-hour peak periods of shift-change traffic on Shaw Creek Road approximately 4 hours apart. During shift changes, up to 180 personal incoming shift vehicles could arrive at the TAPS parking area/bus station, and up to the same number could depart the parking area/bus station approximately 4 hours later.

A traffic noise analysis, similar to the one described above, was performed to determine the increase in noise that shift-change traffic would cause at each of the seven receiver locations close to the existing Shaw Creek Road if the bus station were located near the TAPS crossing. The results of that analysis are shown in Table 4.5-3.

Table 4.5-3 Shift-Change Traffic Peak-Hour Noise Levels for Residences Located Near Shaw Creek Road With Bus Station Near the TAPS Crossing

Receiver #[1] (Name)		~ Distance to Shaw Creek Road[2]	Shielding[3]	Existing Noise[4]	Projected Total Noise[5]	Projected Increase in Noise[6]
R1	(Harrild)	300	No	42	48	**+6**
R2	(Newman-1)	350	Some	35	46	**+11**
R3	(Newman-2)	100	No	32	**53**	**+21**
R4	(Teck-Pogo Inc.)	40	No	32	**59**	**+27**
R5	(Naegele)	240	No	32	49	**+17**
R6	(Thorn)	200	No	32	49	**+17**
R7	(McNabb)	910	No	32	40	**+8**

1 Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
2 Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
3 All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
4 Estimated existing noise level from measurements in similar areas.
5 Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
6 Values in **bold** font indicate moderate or greater impact.

Hourly average noise levels were projected to range from 40 to 59 dBA during each of the hour-long periods when workers were driving to and from the TAPS crossing parking area/bus station. Five of the seven residences either measured 50 dBA or greater, or had increases over existing noise levels of 10 dBA or greater. Under the project criteria, R1 would experience a moderate impact, R2 and R7 would experience a moderate to high impact, and R3 to R6 would experience a high impact. Receivers R3 and R4 were projected to have peak-hour traffic noise levels at or above 52 dBA, and increases of 20 dBA or greater.

Mitigation Because of the low existing noise levels and the projected high impacts from shift-change traffic, the following noise mitigation could be considered:

- Restrict shift changes to daytime hours between 8:00 AM to 6:00 PM on weekdays. This time restriction would eliminate increased noise levels during evenings, at night, and on weekends when increased noise would be most bothersome to residents.
- Encourage car-pooling or worker- or Applicant-chartered buses, to reduce the total number of vehicles using the TAPS crossing parking area/bus station. Reducing traffic by 50 percent could reduce noise levels by 4 to 6 dBA.
- Locate the bus station adjacent to the Richardson Highway so that only the buses would traverse Shaw Creek Road.

Under ideal conditions, a 10-dBA reduction from implementation of the second and third mitigation measures would reduce impacts to low or moderate for all receivers, except R3 (moderate to high) and R4 (high). Attaining a full 10-dBA reduction, however, would depend on the success of reducing traffic by 50 percent, and the more problematical success of limiting vehicle speeds to 25 miles per hour. Other mitigation measures for traffic noise, such as a noise wall, were not considered feasible or reasonable, given the location of the road, and required access to the properties from Shaw Creek Road.

Shift-change traffic ─ Richardson Highway bus station If the bus station were located adjacent to the Richardson Highway, rather than near the TAPS crossing, approximately six buses would traverse Shaw Creek Road for shift changes rather than the workers' vehicles. Table 4.5-4 presents peak-hour noise levels for the same residences assuming six buses, five passenger cars, one medium truck, and one heavy truck during a 1-hour period.

Hourly average noise levels were projected to range from 36 to 54 dBA during each of the hour-long periods when buses were driving to and from the mine site. For each residence, these values were approximately 5 dBA lower than those in Table 4.5-3 with the bus station located near the TAPS crossing. Four residences measured increases over existing noise levels of greater than 10 dBA, with receiver R4 reaching a level greater than 50 dBA. Under the project criteria, R2 would experience a moderate impact, R3, R5, and R6 would experience a moderate to high impact, and R4 would experience a high impact.

It is important to remember that the peak-hour levels of traffic noise shown in both Tables 4.5-3 and 4.5-4 would occur only during two, 1-hour periods approximately 4 hours apart, and only once every 4 days.

Table 4.5-4 Shift-Change Traffic Peak-Hour Noise Levels for Residences Located Near Shaw Creek Road With Bus Station on the Richardson Highway

Receiver #[1]	(Name)	~ Distance to Shaw Creek Road[2]	Shielding[3]	Existing Noise[4]	Projected Total Noise[5]	Projected Increase in Noise[6]
R1	(Harrild)	300	No	42	44	+2
R2	(Newman-1)	350	Some	35	41	**+6**
R3	(Newman-2)	100	No	32	48	**+16**
R4	(Teck-Pogo Inc.)	40	No	32	**54**	**+22**
R5	(Naegele)	240	No	32	44	**+12**
R6	(Thorn)	200	No	32	44	**+12**
R7	(McNabb)	910	No	32	36	+4

1 Receivers were numbered from Richardson Highway toward the end of Shaw Creek Road, and include resident's name.
2 Distance from house to closest point on Shaw Creek Road in feet. For receivers 6 and 7, distance is to proposed new road alignment.
3 All residences, except one, have a direct line-of-site to the road; however, Receiver # 2 is shielded from the road by topography foliage.
4 Estimated existing noise level from measurements in similar areas.
5 Projected noise level combining Pogo-related traffic with existing noise level. This level is the noise level at outside wall of the residence, and does not consider the noise abatement characteristics of the wall and insulation.
6 Values in **bold** font indicate moderate or greater impact.

- Tenderfoot egress Under this sub-option, only very low impacts were identified because of the distance between any noise-sensitive receivers and the proposed route. Noise from trucks could, at times of low ambient noise, be audible at residences R6 and R7, located closest to the proposed intersection of the Tenderfoot egress route and the proposed extension of Shaw Creek Road. These noise levels, however, would be below the project criteria, and only very low impacts were projected. Noise from the trucks was not projected to exceed the existing ambient levels at the other five receivers near Shaw Creek Road.

Use

- Road open to everyone
  - Shaw Creek Road/Rosa egress An analysis of this sub-option was performed. It assumed that 25 passenger vehicles not related to the Pogo project, 5 medium trucks, and 5 heavy trucks per hour were allowed to use the Hillside all-season road *in addition to* Pogo-related traffic. Unlike the shift-change traffic scenarios discussed above, this traffic could occur during any 1 or more hours of the day or night. This traffic volume would account for the worst-case scenario of allowing everyone to use the Shaw Creek Hillside all-season road. Under this scenario, projected hourly noise levels increased by approximately 1 to 2 dBA over the option for only Pogo project-related use (excluding shift-change traffic). This slight increase in noise levels could result in an additional traffic noise impact at receiver location R4 adjacent to the existing Shaw Creek Road. That additional worst-case scenario impact in and of itself would be low because the projected increase would be less 5 dBA or less. This increase, however, would be in addition to increases from Pogo-related traffic. For receiver R4, these combined increases would approach 50 dBA, which has been defined as a high impact (Table 3.9-2). A level of 50 dBA, however, is considered quiet, or the equivalent of light auto traffic at 100 ft (Table 3.9-1). No other additional

noise impacts were projected under the different use options for the all-season road option.

Disposition Of the all-season road disposition options, only removal and reclamation of the road would provide a substantial reduction in noise levels. If the road were left open for commercial and industrial uses, or left open for use by everyone, future noise levels would depend on the actual extent of use. Under either of these two options, however, future noise levels were not expected to exceed those projected during mine operations by more than 1 to 2 dBA as described immediately above in the road use subsection (Table 4.5-2and Figure 4.5-3).

Power Line Route

- Shaw Creek Hillside Construction of this route was projected to result in very low noise impacts to any residences because of the distance from the alignment to noise-sensitive receivers.

Air Access

Airstrip Traffic It was estimated that approximately 100 flights per year, or approximately two per week, would be required to support the mine area facilities under this all-season road alternative. Because of the moderately high level of existing air traffic in the area, flight paths that avoid sensitive areas, and the relatively limited number of aircraft that would access the airstrip, a low noise impact was projected.

Alternative 3

Surface Access

Route Access from the Richardson Highway to the South Ridge all-season road would pass near Quartz Lake, but would be substantially farther from the cabins on the lower Goodpaster River. The distance from the South Ridge all-season road route to sensitive receivers in these areas would be more than 1,000 ft; therefore, only low noise impacts were projected at receivers in this area. This level of impact does not mean that noise from vehicles would not be audible. The projected noise from truck operations, however, would be well below the impacts criteria in Section 3.9.3 (Noise and Vibration Criteria) and was not projected to exceed 25 to 30 dBA L_{eq}, which is equal to or below the average ambient noise for the locations at issue. There would be potential for Quartz Lake residents and lower Goodpaster River cabin owners, during times of low ambient noise, to hear some road traffic. These noise levels would have a low impact, and noise from trucks would be unlikely to be audible inside the residences.

Use The three use options for the all-season road under this alternative were not projected to cause a noticeable change in overall noise levels.

Disposition Same as Alternative 2.

Air Access

Airstrip Traffic Same as Alternative 2.

Alternative 4

Route Under Alternative 4, winter-only access would be constructed in the Shaw Creek Flats. Projections on Figure 4.5-3 show that noise levels would exceed the ambient levels at locations within 350 ft to 400 ft of the proposed Shaw Creek Flats winter route. No noise-sensitive receivers were identified; therefore, no noise impacts were identified.

Use Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, noise impacts from public and logging use of the DOF road would begin to approach those described for Alternative 2, except the daily Pogo traffic noise would not occur.

Air Access

Airstrip Traffic Under this winter-only access alternative, an estimated 500 flights per year (versus 100 for Alternatives 2 and 3) would use the airstrip, an average of between 1 and 2 flights per day. The additional aircraft under this alternative still were not projected to cause a noticeable increase in the overall noise environment. As described under Alternative 2, the proposed flight paths would avoid sensitive areas and only low noise impacts were projected.

4.5.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative noise impacts other than those associated with road reclamation.

- All-season Road Maintained The primary area for cumulative noise impacts concern would be at the residences located along the existing Shaw Creek Road. It would be possible with continued all-season road operation that traffic could increase substantially over time from logging, other industrial/commercial developments, and a road open to the public. For a least one residence on Shaw Creek Road, this cumulative increase could approach a high impact.

  In other areas, because most of the additional noise sources would be sporadic in nature and would occur over a large area, it is not possible to accurately quantify and provide cumulative noise levels. Existing and future noise sources, however, when combined with noise levels from Pogo Mine operations, were not projected to result in any high local *long-term* noise impacts. There may be times, in certain areas, where the combined noise from different sources might result in a noise level increase of greater than 3 but less than 10 dBA, which has been defined as moderate. Such an increase, however, most likely would be short term in nature, and would not result in more than a short-term noise impact.

  An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body would have relatively few additional cumulative noise impacts because most of the existing noise-producing infrastructure would still be used. Development of a hypothetical Sonora Creek mine or a hypothetical Slate Creek mine would increase the geographic distance over which human-generated noise would occur, but because noise levels attenuate relatively quickly with distance from the source, high noise levels would be restricted to the near vicinity of these hypothetical new mines.

  As is shown in Figures 4.5-1 through 4.5-3, noise level increases would occur within 2 to 3 miles of a mine during construction and within 1 to 2 miles of a mine during operations. In addition, noise level increases could be expected within 1,000 ft of a mine access route. Because these hypothetical mines would be in a remote area, with low existing noise levels, there would be potential for noise level increases along trails and other areas that would be used by nonmotorized users such as cross-country skiers, hikers, and mushers. The actual increase in noise would depend greatly on the distance from the mine to the trail, weather conditions, and topography between the trail and the mine or haul route. Unless a trail were within 2 miles of a mine, however, the noise level increase would be less than 3 to 5 dBA; therefore, no high noise impact would occur. There would be times, however, when mining operations might be audible at greater distances due to atmospheric conditions. As discussed earlier, however, noise level increases would be within the EPA criteria, and overall mine-related noise levels would remain at or below 32 to 35 dBA at distances greater than 1 to 2 miles from the mine site. Thus, human noise as a factor disturbing the natural tranquility of these presently remote areas could affect the experiences of nonmotorized backcountry users, but cumulatively it largely would be below the levels considered to be a high impact based on intensity of noise levels (Table 3.9-1).

4.6 Wetlands

Unless otherwise stated, the degree of wetland impacts is discussed below in the context of the Shaw Creek drainage, the Goodpaster River drainage, and the north side of the Tanana River drainage from the Goodpaster River mouth to where the Tanana and Delta rivers join. Wetland regulation is aimed at protecting water resources, and this area encompasses the hydrologic units that would be directly affected by project activities. The degree of wetland impacts is related to several other resources (e.g., wildlife, surface and groundwater hydrology, and water quality) that are discussed in more detail elsewhere in Chapter 4.

Section 3.11 lists wetland functions expected in the four main hydrogeomorphic (HGM) wetland types of the project area. The ways in which those functions might be affected by project activities are briefly discussed below, by function. Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to or removal of the vegetative mat. And the word “disturbance” alone is used generically to include clearing and surface disturbance.

Modification of Groundwater Discharge Slope wetlands perform the function of modifying groundwater discharge. This function would be eliminated in areas that were filled, or possibly would be displaced to areas adjacent to the filled area, resulting in those areas becoming wetter. In areas that were cut – for example, on the upslope sides of roads or building pads – groundwater discharge might still occur, but that discharge would no longer occur through an organic soil layer; the resulting runoff would be faster without the surface soil and vegetation to moderate the flow, and might cause erosion or sloughing of soils. This change in groundwater discharge might also lower base flow in creeks downstream. Groundwater flow might be disrupted where project activities cause subsurface changes, such as compaction of soils or backfill with material that has transmissivity different from that of the natural substrate. Disruption of groundwater flow might alter the locations of groundwater discharge upslope or downslope of the areas of disturbance. Clearing of wetlands above the herbaceous layer would not likely alter this function.

Modification of Stream Flow All project area wetland types moderate stream flows, but in different ways. Flat wetlands lessen storm flows in streams, primarily by catching precipitation on vegetation and absorbing it in their soils. Slope, riverine, and depressional wetlands similarly slow runoff of direct precipitation, but also slow downstream release of incoming surface flows by resistance of their vegetation and microtopography. Depressional wetlands also detain water by their topography. Riverine wetlands provide a wider flow path for storm waters overtopping stream banks, as well as depressions where those overflows may be detained. Cutting, filling, or grading a wetland would eliminate its ability to perform these stream-modification functions because the water absorption capacity of the soil would be eliminated, along with the microtopographic relief and vegetation of the site that provide roughness against surface water flow. Fills that cut across riverine wetlands, isolating those wetlands from the corresponding creek, would eliminate the floodwater storage function of isolated wetlands. Clearing of overstory vegetation would not alter performance of stream-modification functions. Increased impervious area in a watershed, such as that formed by roads and work pads, would enhance the importance of wetlands downstream of those surfaces for moderating flows to creeks.

Maintenance of Soil Thermal Regime The function of maintaining soil thermal regime is performed by wetlands on permafrost. Although most riverine wetlands probably do not have permafrost, slope, flat, and depressional wetlands may perform this function. In wetlands overlying permafrost, the thick moss cover and organic soil surface insulate the soil against warming in the summer. In addition, the shade from vegetation limits soil warming. When moss and organic soil layers or overstory vegetation are removed by clearing, cutting, or grading, the permafrost may thaw. Mineral fill material has less insulative quality than does organic soil; therefore, filling over wetland surfaces might also lead to degradation of permafrost on that site and in immediately adjacent areas. In some areas, filling would have the effect of eliminating the impermeable layer in the soil and improving drainage through the soil, leading to the conversion of the site to nonwetland. As such a site turned to upland, its wetland vegetation and fauna support functions would be lost, and upland vegetation and fauna support functions would be gained. The ability of the wetland to moderate stream flows would be enhanced by better infiltration (thus recharging ground water) and absorption of water by unsaturated soils. In low-lying areas, and those with ice-rich permafrost, thawing may lead to more ponded conditions and, in some places, to collapse of soils and degradation of permafrost beyond the originally disturbed area. Ponding or degradation of permafrost could lessen the ability of the wetland to moderate stream flows and to retain sediments because of vegetation loss, and would alter the type of wetland vegetation and fauna the wetland would support. Thawing of permafrost may result in exposure of mineral and organic soil that may be subject to erosion and subsequent degradation of water and habitat quality. After perturbation, a maintenance of the soil thermal regime in a wetland is not regained until a moss and organic soil layer is regenerated. This regeneration may require many decades. On some sites, such as those with coarse soils, permafrost may not be regenerated.

Export of Detritus Vegetated riverine wetlands and slope wetlands produce organic matter that may be exported to downstream systems in dissolved and particulate forms. This organic carbon may be dropped directly into streams or may be carried into streams by runoff and flood waters. This carbon serves as an energy source for aquatic organisms, supporting downstream food webs. Activities that remove vegetation from wetlands, such as cut and fill, eliminate the ability of wetlands to perform this function. Clearing of shrubs and trees would reduce the amount of organic material available for export, although the debris and decaying vegetation resulting from clearing might provide a temporary source of additional material for export. Construction of fill pads that isolate vegetated wetlands from streams would inhibit this function.

Modification of Water Quality Slope, riverine, and depressional wetlands perform the function of modifying water quality, which entails removal of suspended and dissolved materials from incoming surface water and retention or conversion of those materials to another form. This function has particular importance in areas where pollutants are generated that wetlands might “treat” before water is discharged to downstream aquatic systems. Filling a wetland would eliminate the function of treating water because the vegetation, soil, and microbes that perform the function would be covered. Excavating or cutting wetlands would severely reduce performance of treating or modifying water quality because several of the features instrumental in the modification would be eliminated: plants, microtopography, soil, and microbes. Clearing wetlands above the herbaceous ground surface would not substantially detract from the function of modifying water quality. The importance of this function would increase in wetlands downstream of soil disturbance, stockpiles, and fill activities.

Contribution to Abundance and Diversity of Wetland Fauna and Vegetation The functions of contributing to the abundance and diversity of wetland fauna and vegetation are performed by all wetlands. Cutting, filling, and grading wetlands would eliminate their ability to support wetland vegetation and fish and wildlife other than disturbance-adapted species. Excavation in low-lying areas, as for gravel pits, might convert wetlands from vegetated sites to ponds that would support different plant and animal species, including fish. Clearing of wetlands would degrade the habitat quality for most animal species that had used the wetlands before clearing. If inappropriately designed, access roads across wetlands that support fish could block access to aquatic habitat. Most project activities would disturb wildlife in adjacent wetlands, limiting their ability to support sensitive wildlife species. Similarly, dust particulates moved during snow plowing, pollutants in water, and increased runoff might slightly alter the plant species in wetlands adjacent to developed areas.

4.6.1 No Action Alternative

Construction of the NMDS and a natural gas pipeline would cause some loss of wetlands through placement of fill or by ground disturbance that causes degradation of permafrost and draining of soils, and would cause degradation of wetland functions by clearing, excavation, and backfill.

Virtually all commercial, industrial, military, and residential growth in the Delta area would entail or promote development of land, primarily along existing roads, for homes, yards, commercial sites, or material sources. A small portion of that developed land would be in wetlands in the lower Shaw Creek drainage. Such development generally would avoid use of wetlands because of their relatively poor building qualities and their regulatory constraints.

The DOF's proposed timber harvests generally would not include substantial wetland areas, but access roads to the timber likely would. Roads would be built in the Quartz Lake area and along the Shaw Creek Hillside, roughly in the same location as the Applicant's proposed Shaw Creek Hillside all-season road. Both forestry roads would entail loss of wetlands along an estimated 10 to 20 percent of their lengths. These roads also would open up new areas for use by ATVs, which tend to use and damage wetlands.

Recreationists would continue to seek new areas to explore, hunt, fish, and use for building cabins. The use of ATVs to support these activities would continue to increase, along with resulting wetland damage.

Overall, the impacts on wetlands in the project area from the No Action Alternative would be minimal until the new forestry road is developed up the Shaw Creek Valley. As that road extends to Gilles Creek, effects of off-road ATV use could gradually grow to become a major impact to wetlands. The degree of impact would depend on how much ATV use grows and whether ADNR or hunting and fishing regulations were implemented to effectively control off-road ATV use.

4.6.2 Options Common to All Alternatives

Although approximately 30 percent of the mine area is wetland (Table 3.11-1), 40 percent of the area that would be disturbed for the facilities would be in wetlands (including cut, filled, and cleared areas). This disproportionate use of wetlands results from the need to site mine facilities on flatter, low-lying areas, which also tend to be wetlands. The acreages of mine area wetland impacts are shown on Table 4.6-1.

Table 4.6-1 Acreage (and Percentage of the Cut, Filled, and Cleared Area) of Wetlands, Waterways, and Uplands Cut, Filled, or Cleared in the Mine Area[1]

Type of Water Body	Area Cut or Filled	Area Cleared Only
Wetland	152 (39)	14 (33)
Other potential waters of the U.S.		
Pond	1	0
Broad river	0	1
Gravel bar	3	1
Total of all water bodies disturbed	155[2] (41)	16 (37)
Upland disturbed, including areas already filled (26 acres)	228	27
Total wetlands and uplands	**383**	**43**

[1] The numbers shown are for Alternative 2. Alternative 3 would require filling 1 more acre of wetland than Alternative 2 at the airstrip for an additional fuel storage area. Alternative 4 would require clearing 6 fewer acres of wetlands than Alternative 2 or 3 because a power line would not be built at the mine. Alternative 4 would require filling 12 to 13 more acres of wetlands than Alternative 2 or 3 because of increased storage space needed for fuel and other supplies to last through the period when winter-only road access were not available.

[2] Rounding error

Tailings Treatment Facility

Together, the dry-stack tailings pile, RTP, and associated access roads and diversion ditches would require approximately 43 acres of cut or fill in wetlands (Figures 2.3-1 and 2.3-1e). The access road and ditches would generally be in nonwetlands. Because the tailings pile and RTP must lie in the bottom of a valley, they would be constructed primarily in wetlands – the dry-stack tailings pile located primarily in flat wetlands and the RTP primarily in slope wetlands. Both would eliminate a portion of Liese Creek and its adjacent riverine wetlands. A nonmineralized stockpile and growth media pile would also be located in valley-bottom slope wetlands. All of the functions of these wetlands would be eliminated, including attenuation of flows in Liese Creek, organic matter export, and wetland flora and fauna support. The effects on wetlands would be high in the context of the Liese Creek Valley, but minor in the context of the Goodpaster and Shaw drainages; all effects would be imperceptible in these contexts.

After mine closure and reclamation, parts of the RTP area likely would regain depressional wetland status if graded to hold water. They would regain some stream flow moderation and fauna and flora support functions.

Mill and Camp

The mill and camp and associated access roads, construction road, and diversion ditches would require cut or fill of approximately 27 acres of wetlands (Figures 2.3-1, 2.3-1c, and 2.3-1d). The mill site would be mostly located in uplands. The other components would be located largely in flat and slope wetlands, impinging on riverine wetlands only minimally. These components would eliminate functions similar to those described for the tailings disposal system. All these facilities would be laid out roughly parallel to the slope; therefore, they would likely disrupt the groundwater discharge function of the remaining slope and riverine wetlands downslope. Wetlands downslope of the road, mill, and camp pads might become drier because they would not receive water from upslope. Again, the impacts on wetlands would be high only within the context of the Liese Creek Valley, but would be minor and undetectable in the context of the Goodpaster and Shaw Creek drainages. After mine closure, the mill and camp pads would be ripped and recontoured. After many decades, these sites could regain some wetland functions such as wildlife support and stream flow attenuation, even if they did not regain wetland status.

Gravel Source

Gravel would be excavated near the airstrip, below the 1525 Portal, at the mouth of Liese Creek Valley, above the dry stack in Liese Creek Valley, and on the west side of the Goodpaster River south of the 1525 Portal (Figures 2.3-1, 2.3-1a, and 2.3-1b). Growth media piles would be similarly dispersed throughout the mine area.

The borrow sources in Liese Creek Valley would require excavating approximately 3 acres of slope and flat wetlands. The proposed gravel pits and growth media piles at the airstrip would require cutting or filling approximately 3 acres of slope, flat, and riverine wetlands. The north pit at the 1525 Portal would be located in 4 acres of flat and slope wetlands, and the growth media piles there would require filling approximately 2 acres of slope and flat wetlands. The gravel pits on the west side of the Goodpaster River south of the 1525 Portal area and the associated road and growth media piles would entail cut or fill of approximately 30 acres of flat and slope wetlands next to the river and of riverine wetlands. Approximately 9 acres of that fill would be temporary.

Gravel excavation or placement would eliminate most functions of the affected wetlands, including stream flow attenuation, organic material export, maintenance of permafrost, and vegetation and wildlife (potentially including fish) support. The ability of the wetland soil and vegetation to filter pollutants from adjacent development also would be lost. Groundwater discharge would still occur in the gravel pits.

The gravel pits on the Goodpaster Valley floor, even those sited in uplands, likely would become ponds; therefore, gravel pit development would result in a net gain of wetlands or water bodies. The ponds would support wetland fauna after reclamation, and some likely would become accessible to fish in the Goodpaster River. The adverse impacts of wetland elimination would be moderate in a local context because a substantial wetland area would be lost; however, the adverse effects would be offset by pond creation, resulting in a negligible impact overall.

Construction Camp

The construction camp would largely use existing disturbed pads (Figure 2.3-1a). Additional surface disturbance for the camp, water treatment plant, and roads would affect approximately 6 acres of primarily flat and slope wetlands. Most of these fills would be adjacent to existing surface disturbance, and some of the functions of wetlands may have already been degraded. The functions of these wetlands would be eliminated. The water quality improvement functions of the remaining downslope wetlands in the 1525 Portal area would become even more important for cleansing of water before it flowed into the Goodpaster River. The impact of the loss of these wetlands would be moderate on a local scale; the functions of these wetlands are more important than those in other areas because of their proximity to the river, but the absolute area of loss would be small. In the context of the Goodpaster and Shaw drainages, the impact would be low.

Laydown Area

Impacts of laydown areas at the airstrip and mill are addressed in discussions for those project components. The laydown area at 1525 Portal would require placing fill in approximately 10 acres of slope and flat wetlands near the Goodpaster River (Figure 2.3-1a). The functions of these wetlands would be eliminated, including maintenance of base flow to the river, attenuation of flood flows, detritus export, and wildlife and vegetation support. The laydown area would also adversely affect adjacent wetlands through generation of dust and water containing low levels of pollutants. Therefore, the water quality maintenance functions of adjacent wetlands would become more important. The laydown area would probably disrupt the groundwater discharge function of downslope wetlands. Filling of wetlands in the 1525 Portal laydown area represents a moderate impact in a local context because it is a substantial area of a relatively important type of wetland, near the Goodpaster River. In the context of the Goodpaster and Shaw drainages, the impact would be low.

Water Supply

- Wells The impact of water supply wells would be negligible, limited to small surface disturbance during drilling of the wells and installation of pipes leading to or from the wells (Figure 2.3-1a). Wetland surfaces would be disturbed, but no functions would be eliminated. This impact would be negligible for all wells.

Water Discharge

- Domestic wastewater The sewage treatment plant near the 1525 Portal would require filling less than an acre of flat wetland. The functions of that wetland area would be lost. The impact would be negligible.

Fuel Storage Location

Temporary fuel storage for the development phase would occur below the 1525 Portal and at the airstrip within areas directly disturbed for other components discussed above. This disturbance would represent a minor impact given the low risk of a substantial spill and the short duration of the development phase.

Air Access

- Airstrip The airstrip itself would be sited to largely avoid wetlands (Figures 2.3-1, 2.3-1b, and 3.11-2). Approach and departure clearance requirements, however, would necessitate clearing taller vegetation from 8 acres of wetland and gravel bar (flat, some slope), and construction of the airstrip, apron, and roads would require filling approximately 4 acres of flat and slope wetlands. Laydown areas would require filling 9 to 22 acres of flat and slope wetlands. The wildlife support functions of the cleared wetlands would be degraded; other functions of cleared areas would not be substantially affected. Clearing in wetlands or uplands adjacent to riverine wetlands would detract from their fish habitat qualities. Filling of meandered dry channels could cause some localized scouring of river channels. Such fill would eliminate the functions of affected wetlands, including stream flow moderation, detritus export, groundwater discharge, and vegetation and wildlife (including fish) support. Loss and alteration of riverine side channel wetlands would be a major impact locally (loss of fish habitat and localized alteration of flooding and scour), but a minor one in the context of the Goodpaster and Shaw Creek drainages. The other wetlands that would be affected would be on the margins of much larger wetlands that would generally remain undisturbed. Because the wetlands are near other affected wetlands and connected to the Goodpaster River, that loss would represent a moderate impact in a local context.

The access road from the construction camp and 1525 Portal area to the airstrip would require cut and fill in 13 acres of wetland and the Goodpaster River gravel bar. It would be located primarily in flat wetlands, but would cross riverine wetlands at Liese Creek, on the gravel bar, and in some areas of slope wetlands. The access road would eliminate functions of those areas, including moderation of stream flows and wildlife support. Elimination of these functions would represent a moderate adverse impact locally because the area of wetland loss would be substantial, and those wetlands are near the Goodpaster River, but a low impact in the context of the Goodpaster and Shaw drainages.

Use and Disposition Use only by the Pogo project during mine operations and removal and reclamation at mine closure would have the impacts described above. Use of the airstrip by other industrial/commercial users or by everyone, during and/or after mine closure, could lead to slightly more development in the immediately adjacent wetlands if such users received approval to establish permanent operations. This additional development likely would not lead to substantial adverse effects on wetlands.

4.6.3 Options Not Related to Surface Access

Alternative 2

Power Supply

- Power line Using power from the regional grid would require constructing a transmission line from near the Richardson Highway to the mine site. This construction activity would require clearing and slightly disturbing the ground surface of approximately 119 or 158 acres of wetlands and other water bodies, depending on the route. The effects of this clearing for each route are discussed in Section 4.6.4 below.

  The power line from the Goodpaster River to the mill and camp area would require clearing approximately 6 acres of wetlands and minimal excavation and backfill in wetlands to install the power line. Wildlife habitat functions would be slightly degraded. This degradation of wildlife habitat function would represent a minimal impact on wetlands.

Water Discharge

- Soil Absorption System
  - Adjacent to airstrip This option would be constructed primarily in uplands, but would require eliminating the upper ends of two side channels of the Goodpaster River. The stream flow moderation and wildlife, particularly fish, support functions of these waterway areas would be lost. This loss of wetland functions represents a minor additional impact to wetlands (after the lower ends of the channels are filled for the airstrip).
  - Saddle above Pogo Ridge The exact location of this option has not been defined. Because much of the area above Pogo ridge is wetland, elimination of up to 7 acres of flat wetland is assumed for this option. Additional wetland area would likely be disturbed for site access and installation of the pipe to the site. The functions of

these wetlands would be eliminated, including permafrost maintenance and flora and fauna support. This loss of wetland functions would be a minor impact because it would not affect areas outside the area directly disturbed and would occur far from creeks. The affected wetland acreage would be greater than if located at the airstrip, but the value of the wetlands that would be affected on Pogo Ridge is lower than that of the channels that would be affected at the airstrip; thus, the two options are approximately equivalent

- Underground Injection Wells Under certain circumstances these wells would have the capacity to increase the groundwater table level and result in surface discharge through low-elevation swales and otherwise dry sloughs in the general vicinity of the wells. This surface discharge could create small, scattered, wetland-like areas. Their formation, however, likely would be sporadic and ephemeral. Thus, if this situation were to occur, the wetland benefits would be small.

Alternative 3

Power Supply

- Power line Same as Alternative 2.

Water Discharge

- Direct Discharge to Goodpaster This option would entail a negligible impact to wetlands (0.1 acre) where the road to the discharge point would be constructed across complexes of flat, slope, and riverine wetlands.

Alternative 4

Power Supply

- On-site generation On-site power generation would require the transport, transfer, and storage of approximately 4.2 million gallons of diesel fuel annually. Fuel storage would be located at the airstrip. Transport and transfer of fuel would substantially increase the risk of spills into wetlands. These activities also would increase road traffic, which would result in an increase in dust and sediment-laden road runoff into wetlands adjacent to the road. Given the moderate risk of a serious spill, the moderate risk that the spill would occur in wetlands (based on proportion of the access road crossing wetlands and storage in Goodpaster Valley wetlands), and the small acreage of wetland that likely would be directly affected, these impacts would be moderate and higher than potential fuel spill impacts associated with use of a power line. On-site generation also would require larger fuel storage areas at the airstrip, mostly in wetlands.

Water Discharge

- Off-river treatment works The treatment works would be constructed largely in the pits left after excavation of gravel from an upland site at the north end of the airstrip. The effects of the gravel extraction are described in Section 4.6.2 above. The treatment works would have no additional wetland effects beyond those described above for the gravel pits, which are essentially the same between the alternatives.

4.6.4 Options Related to Surface Access

The acreages of impacts to wetlands resulting from surface access and power line construction from the Richardson Highway to the Goodpaster River Bridge are shown in Table 4.6-2 for each alternative. The same impacts by HGM wetland type are shown in Table 4.6-3.

Alternative 2

Surface Access

Route

- Shaw Creek Hillside all-season road This section discusses the impacts of the road itself; the effects of its use are presented under the road use section below.

  This alternative would cut or fill 120 acres of wetlands and other waterways. Of the 23 borrow sites that would be used for road construction, 15 would be located completely in uplands. The other eight would affect wetlands, but at only four of those sites would wetlands constitute more than 10 percent of the area. The functions of the wetlands cut or filled would essentially be eliminated. These wetlands would be affected as described earlier in this section. Comparison of the HGM wetland types that would be affected by cut or fill (Table 4.6-3) to the amount of those types present in the corridor (Table 3.11-4) shows the route would disproportionately affect flat wetlands (60 percent used versus 43 percent present) and avoid use of slope wetlands (28 percent used versus 44 percent present).

Table 4.6-2 Acreage and (Percentage of Cut, Filled, and Cleared Area) of Wetlands, Waterways, and Uplands Cut, Filled, or Cleared for Surface Access and Power Line Construction[1]

	Alternative 2–Shaw Creek Hillside		Alternative 3–South Ridge		Alternative 4 –Shaw Creek Flats Winter-Only Access	
Type of Water Body	**Cut and Filled**	**Cleared Only[2]**	**Cut and Filled**	**Cleared Only[2]**	**Cut and Filled[3]**	**Cleared Only[4]**
Wetlands	93 (12)	157 (26)	75 (10)	118 (22)	99 (19)	50 (96)
Other potential waters of the U.S.						
Pond	23[5]	1[6]	0	1[6]	0	0
Broad river	0	0	0	0	0	0
Gravel bar	5	0	0	0	5	0
Subtotal	120[7] (16)	158[8] (26)	75 (10)	119[8] (22)	103 (20)	50 (96)
Total all wetlands	**278**		**194**		**153**	
Uplands	641	453	684	415	404	37
Total wetland and upland	761	611	759	534	507	87
Total by alternative	**1,372**		**1,293**		**594[9]**	

1 Includes camps, airstrips, and gravel pits; does not include power line for Alternative 4.
2 Clearing would occur primarily for the power line.
3 Includes perennial winter trail area graded below soil surface (approximately 24 acres).
4 Perennial winter trail area cleared only.
5 Existing gravel pit.
6 Ponds within corridor would not be cleared.
7 Rounding error.
8 Primarily within the area cleared for the road or for power line operation. Power line construction might require an additional 29 acres of fill or soil disturbance under Alternative 2 and an additional 17 acres under Alternative 3.
9 Clearing for the Shaw Creek Hillside power line ROW (with winter-only access) would affect 161 acres of wetlands. If this option were selected, it might also require up to an additional 32 acres of fill or soil disturbance in wetlands for power line construction.

Table 4.6-3 Acreage and (HGM Class Percent of Total) of Cut, Fill, or Clearing by Hydrogeomorphic Wetland Type for Surface Access and Power Line Construction[1]

Hydrogeomorphic Wetland Type	Alternative 2–Shaw Creek Hillside		Alternative 3–South Ridge		Alternative 4–Shaw Creek Flats Winter-Only Access	
	Cut and Filled[2]	Cleared Only[3]	Cut and Filled	Cleared Only[3]	Cut and Filled[4]	Cleared Only[5]
Flat	59 (60)	60 (38)	50 (67)	58 (48)	71 (69)	21 (42)
Slope	28 (28)	62 (39)	20 (27)	38 (32)	22 (21)	27 (54)
Depressional	23[6] (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Riverine	11 (11)	36 (23)	5 (6)	23 (19)	10 (10)	2 (4)
Subtotal	120 (100)	158[7] (100)	75 (100)	119[7] (100)	103 (100)	50 (100)
Total by alternative	**278**		**194**		**153**	

[1] Includes camps, airstrips, and gravel pits; does not include power line for Alternative 4.
[2] Percentage does not include depressional wetland type. See note 6. If depressional acreage were included, these percentages would be: flat – 49, slope – 23, riverine – 9, depressional – 19.
[3] Clearing would be primarily for the power line.
[4] Includes perennial winter trail area graded below soil surface.
[5] Perennial winter trail area that is only cleared.
[6] This existing borrow source is presently an open-water pond. This acreage was not used in calculation of HGM wetland type percentages to provide a better reflection of proportional impacts to relatively undisturbed wetlands.
[7] Primarily within the area cleared for the road or for power line operation, power line construction might require an additional 29 acres of fill or soil disturbance under Alternative 2 and an additional 17 acres under Alternative 3.
[8] Clearing for the Shaw Creek Hillside power line ROW (with winter access only) would affect 161 additional acres of wetlands: flat – 64, slope – 63, depressional – 0, riverine – 34. If this option were selected, it might also require up to an additional 32 acres of fill or soil disturbance in wetlands for power line construction.

The most important functions lost in flat wetlands would be moderation of stream flow (absorption of precipitation), maintenance of permafrost, and flora and fauna support. Important functions lost in slope and riverine wetlands include groundwater discharge, stream flow moderation, detritus export, and flora and fauna support. The functions of slope wetlands tend to be more important than functions of flat wetlands because slope wetlands tend to be more nutrient rich and water flows through them to sites downslope. Adverse impacts on slope wetlands are more likely to have effects off site than impacts on flat wetlands.

Riverine wetland and water body types would be affected in proportion to their presence in the corridor. Riverine wetlands would be crossed approximately 20 times by the road. Most of the crossing lengths have been minimized by crossing perpendicularly. As in Alternatives 3 and 4, riverine wetlands would be paralleled in the bottom of Wolverine Creek Valley. Riverine wetlands are the most important of the wetland types because effects on them almost certainly extend offsite through water movement and because of their importance to sustaining fish and wildlife populations. The sole depressional water body that would be cut or filled is an existing gravel pit. Its functions would not likely be affected by further gravel extraction. Effects of clearing for the road would be minimal because clearing generally would not occur more than 5 ft beyond cut and fill slopes.

In addition to wetland functions lost on site, the road could have adverse effects on off-site wetlands. Dust and water-borne pollutants generated on the road could slightly alter the vegetation of adjacent wetlands. The road would alter downslope drainage. In wetlands with substantial downslope surface and shallow subsurface water movement (slope and riverine), the road would block that drainage, directing it to cross culverts. The continuing downslope flow would be more concentrated and could potentially cause erosion if not appropriately dissipated. Drainage changes would cause some wetlands to become wetter and others to become drier. These effects are not expected to extend far upslope or downslope, assuming appropriately spaced and sized cross culverts. The road would create more impermeable surface in the Shaw Creek and Goodpaster River drainages; downslope wetlands (and uplands) would effectively attenuate the resulting increased runoff.

Mitigation measures assumed to be implemented include:

- Clearing only within the cut or fill footprint on low-gradient wetlands, with clearing to 5 ft beyond the cut or fill footprint in wetlands on hillsides and sand dunes, and farther only as necessary to maintain safe sight distances
- Use of frequent cross culverts to maximize maintenance of natural drainage conditions
- Use of measures to prevent erosion at culvert inlets and outlets
- Use of appropriate measures, based on site-specific conditions, to minimize erosion in ditches and on cut and fill slopes

While the impacts on wetlands from the road itself would be substantial within each wetland complex through which it passes, the effects would be minor in the context of the Shaw Creek and Goodpaster drainages. The impacts would be dispersed along the 49-mile route, predominantly in the Shaw Creek drainage that supports extensive wetlands. The impacts would be focused on flat wetlands, which are the driest and least valuable of the wetland types in the area.

- Tenderfoot egress The direct wetland impacts would be the same as for the option above because the additional segment of road would not cross wetlands. Construction on unstable upland soils above Rosa Creek would create a higher potential for erosion or slope failure that could adversely affect wetlands along the creek. These impacts, however, would be low.

Use

- Pogo project only Use of the road by Pogo operators would cause off-site wetland impacts resulting from degraded road runoff and dust, which would slightly alter vegetation near the road. Accidental spills of pollutants would have more distinctly adverse effects on wetland biota. Disturbance to sensitive wetland-dependent wildlife could extend to many hundred feet from the road.

Although measures would be implemented to limit traffic to Pogo Mine operations, some trespass would inevitably occur. Availability of a road would tempt ATV users to access the road beyond the gates. Because of their relative openness, wetlands might serve both as the route to access the road from the Richardson Highway and as travel routes, once ATVs left the mine road away from the highway. Vehicle use in wetlands would damage vegetation and organic surface soils. In extreme cases, this damage would be enough to cause erosion, water quality degradation, and habitat damage. Pogo operators would be able to distinguish between those using the road legally and those not. Pogo operators would have some incentive to limit unauthorized road use because of commitments made during the mine permitting process and safety concerns. The secondary impacts to wetlands caused by the road would be minor in the context of the Shaw and Goodpaster drainages because the wetland resources of those drainages are vast, management could limit the impacts, and the impacts likely would be widely dispersed.

- Pogo project and other industrial/commercial users only   Use of the road by other industrial and commercial operators would increase the off-site wetland impacts resulting from degraded road runoff and dust, potential pollutant spills, and disturbance to sensitive wetland-dependent wildlife. Trespass impacts would be slightly greater because management would be more difficult. The impacts would still be minor in the context of the Shaw and Goodpaster drainages.

- Use by everyone   This option would have the same impacts as discussed above, plus impacts caused by individual road users. These users would increase traffic and its associated dust, water quality, and wildlife impacts. Such use would substantially increase the dispersion of ATVs into areas where they are presently not used. Moose hunting, in particular, would provide a draw for ATV users into the Shaw Creek Valley. As stated above, wetlands likely would experience a disproportionate share of that use, and would be damaged. Habitat and water quality impacts would result. Because ATV use is largely unregulated, mitigation of this damage likely would not occur. Habitat and water quality impacts would begin immediately and grow over time. Adverse effects on wetlands in some side drainages would be high. Depending on how many users the area attracted, the routes they took, whether ADNR could effectively limit off-road ATV use, and whether hunting regulations were changed to effectively limit ATV use, these secondary effects of the road could become moderate over time in the context of the Shaw Creek and Goodpaster River drainages.

  - Security gate at Gilles Creek   The impacts for this option would be the same as described above east of Gilles Creek. The impacts west of the Gilles Creek gate would be the same as for use by everyone described above. Over time, the adverse impacts to wetlands from off-road ATV use could grow to become moderate within the context of the Shaw drainage.

Disposition

- Remove and reclaim   No additional wetland impacts would result.

- Open for industrial/commercial users   The effects described under use above for Pogo and other industrial/commercial users only would continue beyond the Pogo mine life, resulting in more minor roadside wetland degradation. The impacts would be minor.

- Open for everyone   Impacts for this option would be the same as under use by everyone above, but would continue indefinitely. The adverse wetland impacts would be high in certain localities, but moderate in the context of the Shaw and Goodpaster drainages.

  - Reclaim past Gilles Creek   Impacts for this option would be the same as for remove and reclaim above east of Gilles Creek. The impacts would be the same as for leave open to everyone above east of Gilles Creek.

Power Supply

- Power line route   This alternative would clear 158 acres of wetlands and other water bodies. Approximately 29 acres of primarily cleared area also might be filled or the soil might be disturbed for spur trails and power pole installation. Approximately 26 percent of the power line route would be located in wetlands or water bodies (Table 4.6-2).

Because the power line route would closely follow that of the all-season road, generally just a single, combined corridor would be cleared for both components. The power line would diverge from the road only in the Caribou Creek area and in upper Shaw Creek, where the road climbs onto the ridge to cross the divide into Wolverine Creek Valley (Figure 2.4-3). The power line would traverse extensive wetlands at the crossing of Caribou Creek, twice where it crosses Shaw Creek, in the valley that stretches eastward from upper Shaw Creek, throughout Wolverine Creek Valley, and across the mouth of Contact Creek Valley (Figure 3.11-1).

Where the line followed the proposed road across wetlands, power poles would be placed as close to the road as possible to minimize disturbance of wetlands. Some clearing and spur trail development would be necessary between the access road and the power line for equipment access for pole installation and stringing line. Clearing in wetlands in the power line corridor would generally be limited to areas where vegetation was more than 10 ft tall; in those areas, vegetation would be cleared near ground level by hand, hydro-ax, or other mechanical means, and the vegetation mat would be left intact where feasible. Most wetland access would be on low-ground-pressure vehicles. The portion of the power line between upper Shaw Creek and the divide above Wolverine Creek would be accessed in winter or by helicopter. At the spur trails, fill would be placed as needed to create ramps extending 20 to 40 ft beyond the toe of the road embankment. The spur trails would be sited to minimize disturbance to wetlands. At each pole structure, some ground leveling might be required for pole installation, and pole and anchor installation would require augering or excavation and backfill. Some of the wetlands would require special pile foundations for the poles.

Table 4.6-3 shows the acreages, by HGM wetland type, within the power line corridor on which vegetation would be cleared. Clearing impacts would be distributed among wetland types approximately proportionately to the presence of those types or with a slightly higher proportional impact on riverine wetlands. The primary wetland function that would be altered by the power line installation and maintenance would be wildlife support; understory vegetation also would change. Excavation and backfill and some equipment movements would disturb the soil organic mat. This mat disturbance could lead to degradation of permafrost that could result in conversion of some wetland areas to uplands or could potentially lead to collapse of ground in ice-rich areas. Clearing also could potentially result in degradation of permafrost in the cleared area. Wetland functions would be lost in the wetland areas that would be filled for spur trail development.

Where the power line route diverges from the road route in upper Shaw Creek Valley, the cleared transmission line corridor might serve as a travel corridor for ATV users desiring access to the valley followed by the transmission line. Such ATV use would damage wetlands. Desire for access to that valley is expected to be limited.

The following mitigation measures are assumed to be implemented:

- No operation of heavy equipment in wetlands where equipment could cause substantial disturbance to the root mat
- Span wetlands whenever possible

While affecting an extensive area by clearing, the power line effects on wetlands would be minor in the context of the Shaw Creek and Goodpaster River drainages, for the following reasons: Most functions of the wetlands would remain undisturbed; the affected functions would be altered only to a minor degree; the wetlands disturbed would be predominantly of a lower value than the wetlands that dominate the Shaw Creek drainage; the wetlands disturbed would be a minimal proportion of the project area wetland resource; and clearing would lead to minimal additional use by off-road ATVs.

Sutton Creek In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide.

Wetlands disturbance in the Sutton Creek segment of the power line would total approximately 4 acres. Because the boundaries between wetlands and uplands are more distinct along this route, the power line likely could be sited to avoid some of these wetlands. Wetlands disturbance if the power line were routed adjacent to the road over the divide would total approximately 6 acres. Because the power line would traverse primarily mosaics of wetlands/uplands along this route, wetlands would be more difficult to avoid.

While fewer wetlands would be affected by the Sutton Creek route, the absolute difference would be small, and following the road route over the divide would remove all wetlands impacts from the Sutton Creek drainage.

Alternative 3

Surface Access

Route

- South Ridge all-season road This alternative would cut or fill 75 acres of wetlands or other water bodies (Table 4.6-2). The 46-mile-long route generally follows ridges or upper parts of hill slopes. It is largely in uplands, including crossings of many areas mapped as mosaics of uplands with up to 25 percent wetlands. As in the other alternatives, this option would cut or fill a lower proportion of wetlands (10 percent of total cut and fill area) than are mapped in the project area (15 percent of project area), demonstrating some avoidance of wetlands. The route would cross extensive wetlands only in the Wolverine Creek Valley and along the Goodpaster River at the mouth of lower Contact Creek in the same manner as would the other alternatives. Of the 19 borrow sites along this route, 18 would be predominantly in uplands. While the total (upland and wetland) area cut and filled would be approximately the same as for Alternative 2, the area of wetland and water body cut or filled for Alternative 3 would be approximately 22 acres less than for Alternative 2 (not counting the existing gravel pit pond referenced under Alternative 2 above), and would be 29 acres less than for Alternative 4.

  The same types of on-site and off-site wetland functional losses would result from Alternative 3 as were described for Alternative 2, but the degree of those losses would be less than those for Alternative 2. Not only would fewer wetlands be cut or filled under Alternative 3, but also a lower proportion of the more important riverine wetlands would be used than under Alternative 2. Comparing the HGM wetland types that would be affected by cut or fill (Table 4.6-3) to the amount of those types present in the corridor (Table 3.11-4) shows the route would disproportionately affect flat wetlands (67 percent used versus 61 percent present) while somewhat avoiding use of slope wetlands (27 percent used versus 36 percent present). Impact on riverine wetlands, the most important in the project area, would be small and less than under Alternative 2 or 4.

The wetland impacts of this alternative would be minor in the context of the Shaw Creek and Goodpaster River drainages. They would be widely dispersed over a large area and would be focused on the least important wetland type; and the loss of wetland function would be small relative to the project area's entire wetland resource.

Use

- Pogo project only Same as Alternative 2. Road use impacts would be minor.
- Pogo project and other industrial/commercial users only Same as for Pogo project only use above, plus more effects of on-road use (dust, sediment-laden runoff, potential pollutant spills, and wildlife displacement) and more trespass of ATV users that would travel off the road. Trespassing ATV damage of wetlands would probably be less than along the Shaw Creek route because this route crosses fewer wetlands that are likely to be traversable by ATVs and the moose hunting draw into the Goodpaster Valley likely would be less. Road use impacts would still be minor.
- Use by everyone This option would increase the effects of on-road use (dust, sediment-laden runoff, and wildlife displacement) because there would be more users. Because this option would open the road to all users, off-road use of ATVs likely would be substantially more than under options that limit road use. This route crosses fewer wetlands that could be easily traveled by ATVs than does the Shaw Creek route, but limits the number of points ATVs would depart from the road. Also, there may be less incentive to travel off-road into the wet lowlands in the Goodpaster Valley than in the Shaw Creek Valley, where moose hunting likely provides more of a draw. The direct and indirect impacts associated with this option would be higher than for restricted road use, but still low in the context of the Shaw and Goodpaster drainages because the proportion of wetlands that likely would be damaged would be minimal.

Disposition

- Remove and reclaim Same as Alternative 2.
- Open for industrial/commercial users Same as Alternative 2, but with more trespass off-road ATV use. Ongoing impacts would still be minor in the context of the Shaw and Goodpaster drainages.
- Open for everyone Same as for the option immediately above, but with more off-road vehicle use. The impacts would still be minor.

Power Supply

- Power line route This alternative would clear approximately 119 acres of wetlands and other water bodies for the power line corridor. Up to approximately 17 additional acres might be cleared for access to the power line corridor, might be filled for spur trail construction, or might have the soil disturbed for power pole installation. Approximately 22 percent of the power line route would be located in wetlands (Table 4.6-2). The South Ridge power line would lie in the same general corridor as the South Ridge all-season road, but for most of its length would be offset from it by one-quarter to one-half mile or more (Figure 2.4-3). The road would cross the power line route many times but, unlike

Alternative 2, the power line and road would seldom share the same clearing. The power line would traverse extensive wetlands near Quartz Lake, at the Indian Creek crossing, in the headwaters of Sand Creek (tributary to the Goodpaster River), throughout the Wolverine Creek Valley, and across the mouth of the Contact Creek Valley (Figure 3.11-1). Construction methods would be the same as for Alternative 2.

Both flat and slope wetlands would be cleared in lower proportion than their presence in the corridor. Riverine wetlands would be cleared in greater proportion, with almost all of that clearing in the Wolverine Creek Valley (shared by Alternative 2 route). The types of impacts on wetland functions would be the same as for Alternative 2.

The cleared power line corridor would be unlikely to experience intensive ATV use because ATV users would be more likely to either use the road legally or, if the road were closed to the public, ATV users sufficiently motivated to travel the same direction as the power line likely would trespass on the road. Mitigation measures would be used to restrict ATV use on the power line ROW.

While affecting an extensive area by clearing, the South Ridge Route power line wetland impacts would be minor because most functions of the wetlands would remain undisturbed, the affected functions would be altered only to a minor degree, the wetlands to be disturbed would be predominantly of a lower value than valley-bottom wetlands that dominate the lower Goodpaster and Shaw Creek drainages, and the wetlands to be disturbed are a minimal proportion of the project area wetland resource. Implementing the same mitigation measures suggested for Alternative 2, including use of helicopter or winter access across extensive wetland areas, would reduce wetland impacts to a low intensity.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter-only access The winter-only access route would cut or fill 103 acres and clear vegetation on 50 acres of wetlands and other water bodies (Table 4.6-2). This route combines a 15-mile Shaw Creek Flats winter-only access segment with 31 miles of the Shaw Creek Hillside all-season road (Figure 2.4-3). The all-season road portion of this alternative would have the same type of construction and would incorporate the wetland avoidance and minimization measures described for Alternative 2. That portion of the road would require cut and fill of approximately 79 acres, and its impacts would be similar to those discussed above for Alternative 2.

The first 15 miles of this alternative would cross extensive wetlands on the floor of Shaw Creek Valley before connecting with the Shaw Creek Hillside all-season road route. Because much of this winter-only access route has historically been used by the military, and has recently been used for winter forestry roads, the first approximately 9 miles would require minimal clearing of the existing surface vegetation across an area of approximately 44 acres. Depending on the construction mode, the remaining 6 miles would require more intensive clearing or disturbance of approximately 24 acres. Thus, while for Alternatives 2 and 3 the acreage to be cleared would be primarily for the power line (Table 4.6-2), for this alternative, clearing would be necessary for portions of the winter-only access route.

Two design options were considered for this 6-mile segment: a traditional winter road and a perennial winter trail.

Traditional winter road construction standards With the use of traditional winter road construction standards, approximately 6 miles would be cleared down to the ground vegetation, but the organic soil mat would not be bladed. Atop the cleared area along all 15 miles of the Shaw Creek Flats winter-only access route, a snow and ice road would be built for use each winter.

The acreages in Tables 4.6-2 and 4.6-3 include both the winter-only access segment and the all-season road segment of the alternative. The acreages of cut and fill in wetlands for this alternative shown in Table 4.6-2 are for the perennial winter trail construction standards (discussed below). The option consisting of traditional winter road construction standards would cut and fill 24 fewer acres in wetlands than are shown in Table 4.6-2. Conversely, the acreage only cleared of vegetation would be 24 acres greater.

Like the other alternatives, this alternative would use flat wetlands for cut and fill activities in much greater proportion to their presence in the project area, and would avoid slope wetlands. The effects on wetland functions would be similar in kind to the effects described for Alternative 2 for the all-season road segment that is the same as Alternative 2, but would differ for the first 15 miles of this route. Clearing for a traditional winter road would entail clearing all the way to the ground, but would not cut the vegetative mat. This clearing would eliminate the shading effects of trees and shrubs and reduce the insulating effect of the surface vegetative mat, likely resulting in an increase of depth to permafrost. Permafrost degradation could result in ground collapse in some areas, resulting in ponding and soil exposure.

Depression of the soil surface from vegetation clipping and ground collapse could lead to minor rechannelization of surface water flows, although this is expected to be minimal because the terrain is so level. Exposure of soils or channelization of flows could lead to water quality degradation. This degradation of water quality is expected to be minor because the area is so flat. Clearing also would alter the flora support function (leading to conversion to grass and sedge plant communities) and wildlife support function of these wetlands. These functional changes to wetlands have likely already occurred along most of the first 9 miles of the route due to past military and timber harvesting activities.

Clearing the new 6-mile segment across wetlands could ease its use by ATVs during late winter and nonwinter months, which could damage the wetland surface. Because this alternative would use an existing cleared route for the first 9 miles, this effect would be expected only in the last 6 miles. Once the 15 miles of winter road route were traversed, ATV users would reach the all-season road, from which they might access other wetlands. This alternative would promote substantially less off-road ATV use than would Alternatives 2 or 3 because of the extreme wetness of the winter road corridor that would have to be traversed to access the all-season road during nonwinter periods.

While this alternative would affect a larger acreage of wetland than the other alternatives, 68 acres of the affected wetlands would remain wetlands and retain wetland functions, being altered only by clearing down to the organic mat. As for the other alternatives, the wetland impacts of this alternative would be high on a local basis, but low in the context of the Shaw Creek and Goodpaster River drainages. They generally would be widely dispersed, focused on the less important wetlands, and would represent only a small incremental loss of wetland function in the context of the extensive project area wetlands.

Perennial winter trail construction standards The difference between this option and the traditional winter road option is that the ground surface would be leveled at the start of construction along the 6-mile stretch from the end of the existing 9-mile relatively cleared winter trail/road to where the winter route would join the Shaw Creek Hillside all-season road route. Cut and fill activities would affect 24 more acres of wetlands than would the traditional winter road option. Wetland functions would be affected in the ways described above for the traditional winter road. Along the 6-mile segment requiring more blading, however, more of the insulative organic mat would be removed and more mineral soil would be exposed. There would be greater potential for permafrost thaw, soil collapse, surface flow channelization, and water quality and habitat degradation than for the traditional winter road option.

The wetland impacts of this option would be high on a local basis, but low in the context of the Goodpaster River and Shaw Creek valleys for the reasons described under the traditional winter road option above. Mitigation measures that would minimize these effects include:

- Active and immediate revegetation of exposed soils with native grasses and sedges
- Monitoring of changes in surface water flows and minor redirection of flows to prevent erosion

Power Supply

- Power line route Although the power supply option for Alternative 4 has been defined as on-site generation, as discussed above, there is no reason that a power line could not be selected as the power supply option for the Preferred Alternative to complement winter-only access. If that were to occur, the Shaw Creek Hillside power line route would be used, the same as with Alternative 2. Thus, the effects of constructing this route, in conjunction with winter-only access, would be similar to those described under Alternative 2. It would entail clearing approximately 161 additional acres of wetlands and other water bodies (51 more acres of clearing for ice road and power line than for Alternative 2).

This alternative, however, would have additional minor power line impacts because the first approximately 15 miles of the power line would not be constructed in conjunction with an all-season road. Thus, heavy equipment for pole installation and line stringing would have to be walked down the power line ROW, rather than on the all-season road, likely requiring clearing of vegetation closer to the ground. Up to approximately 32 additional acres might be cleared for access to the power line corridor, might be filled for spur trail construction, or might have the soil disturbed for power pole installation (3 more acres than for Alternative 2).

Clearing for this power line would be more likely to induce ATV use than would the power line for either of the other alternatives because no adjacent all-season road would exist for the first 15 miles. The effects of the power line would be low because most wetland functions would not be substantially affected by construction and the associated

ATV use likely would be low. The low adverse construction effects could be mitigated further by constructing power line segments across wetlands near Keystone Creek in winter or with helicopter support.

4.6.5 Cumulative Impacts

- All-season Road Reclaimed   Absence of an all-season road would limit other resource development activities and human access. Cumulative wetland impacts to the time the road was removed would include those from the Pogo project itself, the road to the mine, and off-road ATV use from the road. These cumulative wetland impacts would be moderate with the Shaw Creek Hillside all-season road and low with the South Ridge all-season road in the context of the Shaw and Goodpaster drainages. Either alternative would have affected a relatively low proportion of wetlands in those drainages, but the Shaw Creek Hillside all-season road likely would have led to more unregulated and damaging off-road activity in wetlands.

- All-season Road Maintained   Mine developments such as a hypothetical Sonora Creek mine would increase wetlands impacts, but its location close to the Pogo project infrastructure would limit those impacts to an assumed 75 acres. A hypothetical Slate Creek mine accessed by extension of the Pogo all-season road would directly eliminate an assumed additional 200 acres of wetlands, including some of high value in the Goodpaster River Valley. The impacts would be limited through permitting processes.

  The maintained road would accelerate timber harvests. While these harvests would focus on uplands, roads would require some wetland crossings, including impacts to valuable slope and riverine wetlands. Timber harvests also could have some minor off-site impacts on wetlands related to sediment-laden runoff and higher peak stream flows. These effects would be greater with a Shaw Creek Hillside all-season road than with a South Ridge all-season road because more timber harvests likely would occur in the Shaw Creek drainage, which contains more wetlands.

  An all-season road open to everyone would cause a moderate cumulative impact to wetlands in the Shaw Creek and Goodpaster River drainages. A few hundred acres of wetlands would be eliminated; a few hundred more would be slightly degraded by proximity to commercial and industrial structures and activity; and more would be severely degraded by recreational and subsistence activities, particularly those employing ATVs. While the impacts would affect a small proportion of the wetlands in the Shaw and Goodpaster drainages, the effects would be detectible on the scale of those drainages.

  Wetlands impacts related to residential and commercial land development near the Richardson Highway would continue to be stimulated by ongoing resource extraction and public use activities associated with the road.

4.7 Surface Disturbance

Table 2.3-6 presents the acreage of existing and expected new disturbance, grouped by project component and the options associated with each action alternative. The acreages vary between the alternatives primarily because of differences in length of the surface access and power line routes, the additional area that would be disturbed at the mine site to provide more laydown area and greater fuel storage capacity necessary for a once-a-year resupply effort under the winter-only access option, and in the water discharge option. This section focuses on the differences in disturbance between the alternatives based on Table 2.3-6. Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to, or removal of, the vegetative mat. And the word “disturbance” alone is used generically to include clearing and surface disturbance.

4.7.1 No Action Alternative

The current DOF 5-year schedule for timber sales (2003–2007) in the Delta area includes four sales on the north side of the lower Shaw Creek drainage and the Tenderfoot area, and four sales in the Quartz Lake and Indian Creek area (ADNR, 2002). These eight sales would disturb approximately 1,313 acres, not including new timber access roads.

With respect to the Pogo project, existing disturbed areas occur along the potential access routes and at the mine site. Up to 55.3 disturbed acres exist along the winter-only access route (Table 3.12-1). Approximately 33 acres of disturbance presently exist at the mine site from Pogo exploration activities by the Applicant and a previous claims owner (Section 3.12).

4.7.2 Options Common to All Alternatives

Approximately 383 acres of disturbance would occur with these common options, all located at the mine site. There would be no substantive differences in disturbance for these options between the alternatives, except for the gravel source option. If gravel were made from crushed mine development rock, as opposed to being mined from gravel pits, approximately 72 fewer acres would be disturbed, leaving a total of approximately 311 acres.

4.7.3 Options Not Related to Surface Access

Table 4.7-1 shows how disturbance acreage would vary between the alternatives for options not related to surface access.

Table 4.7-1 Approximate Clearing or Surface Disturbance (Acres) for Options Not Related to Surface Access[1]

Component/Option/Sub-option	Alternative 2	Alternative 3	Alternative 4
Power Supply			
▶ Power line[2] (differs by route)	602	525	
▶ On-site generation (extra fuel storage and laydown for winter access)			22.7
Wastewater Discharge			
▶ Soil absorption system	4.4		
▶ Direct discharge to Goodpaster River		0.5	
▶ Off-river treatment works			13.1

[1] Includes existing disturbed acreage
[2] Vegetation clearing only

For the power supply component, a power line option would require approximately 602 or 525 acres of clearing, depending on the route. For the on-site generation option, Alternative 4 would require an additional approximately 22.7 acres of surface disturbance for fuel storage

(6.1 acres) and laydown area (16.6 acres) to accommodate storing a full year's supply of fuel and supplies delivered in a short span for winter-only access.

4.7.4 Options Related to Surface Access

Table 4.7-2 shows how disturbance acreage would vary between alternatives for options related to surface access.

Table 4.7-2 Approximate Clearing or Surface Disturbance[1] (Acres) for Options Related to Surface Access[2]

Component/Option/Sub-option	Alternative		
	2	3	4
Surface Access Route			
▶ Shaw Creek Hillside all-season road	770		
✦ Tenderfoot egress from Richardson Highway	43		
▶ South Ridge all-season road		768	
▶ Winter-only access			594
Power Line Route[3]			
▶ Shaw Creek Hillside	602		
▶ South Ridge		525	
Goodpaster Winter Road[4]	32	32	32

1 Includes existing disturbed acreage.
2 Includes ROW, construction camps, airstrips, and gravel sources.
3 Vegetation clearing only.
4 Used during first two winters of project development for all alternatives.

Surface Access

Route

The Shaw Creek Hillside all-season road option would cause surface disturbance to approximately 770 acres if the Shaw Creek/Rosa option were used for the Richardson Highway egress. If the Tenderfoot egress option were used, an additional approximately 43 acres of surface disturbance would occur, for a total of 813 acres. The South Ridge all-season road option would cause surface disturbance to 768 acres. The winter-only access option would disturb approximately 594 acres. This lower disturbance figure reflects the use of existing disturbed winter trails/roads that would eliminate the need for disturbing approximately 15 miles roughly paralleling the route of the all-season road in lower Shaw Creek Valley.

Power Line Route

The Shaw Creek Hillside power line route would clear approximately 602 acres for Alternative 2 while the South Ridge power line route would clear approximately 625 acres for Alternative 3.

4.7.5 Cumulative Impacts

Disturbance is itself an impact on other resources, and those impacts, including cumulative impacts, are described for each affected resource in the other sections of this chapter. Thus, a cumulative impacts discussion for disturbance is not applicable.

4.8 Fish and Aquatic Habitat

In this section, discussion of impacts is considered in the context of the fish populations in the entire drainages of both the Goodpaster River and Shaw Creek. Availability of habitat types varies along a drainage, and while some species use an entire drainage during their various life stages, others are restricted to certain sections for one or more life stages. Thus, impacts in one section of the drainage can have variable effects on populations. This discussion addresses only those project options found to affect water quality, as described in Section 4.3, and those from operational accidents, facility failures, environmental upsets, increased access, and construction activities. In this context, over time the project would have low to moderate impacts on fish habitat and fish populations in the Goodpaster River and Shaw Creek drainages depending on the option selected for each of its components. Other combinations of options, however, could have a relatively moderate to higher impact and could have major impacts on local aquatic habitat over the life of the mine.

4.8.1 No Action Alternative

Impacts under this alternative would come mainly from angling and boating and would follow historical patterns. The present decline in the Delta area population due to the closure of Fort Greely would not result in an appreciable decline in recreational use because present and past effort has been predominantly from nonlocal users and, in the Goodpaster River, by private landowners (Parker, 2000a). Access limitations in both drainages also help keep use low and restricted to the lower parts of both drainages. Harvest and angling effort in the two drainages has increased only slightly over the past 5 years and is lagging behind Alaska's growth rate.

Construction and operation of the NMDS would result in the Delta area population stabilizing at approximately 2,100 residents, below the pre-Fort Greely base closure peak of 2,388 residents in 1993. Even with the high employment during the construction phase of this project, increases in recreational use would be small to moderate due to the limited access to both drainages and the finite number of private parcels in the Goodpaster drainage.

Mineral exploration in both drainages would continue to have no to low impact if recent exploration methods continue to be used. Impacts would be highly localized and come from accidental spills of petroleum products; runoff containing sulphides, metals, and arsenic from exploration sites; and local erosion at staging areas. Considering the likely volume of spills, the present water quality of tributaries draining mineralized zones, as described in Section 3.7 (Water Quality), and natural erosion from floods, impacts would be low.

Impacts could arise from habitat alteration and increased access from incremental development of all-season logging roads by the DOF. Impact would fall primarily in the Shaw Creek drainage. The proposed forestry road would follow closely the Applicant's proposed Shaw Creek Hillside route and would eventually end at Gilles Creek. This road would be open for public use. With proper road design, stream crossings, and maintenance, in addition to logging practices that protect streams, fish, and habitat, the impacts from erosion, sedimentation, stream blockages, and bank destruction would be low to nonexistent. Increased access to the tributary stream crossings would offer angling opportunities that would minimally affect grayling populations due to the small size, seasonal use, and present harvest regulations of the tributaries. The extension of the Quartz Lake logging road into the Goodpaster drainage would be located in the uplands miles from the river and would not cross any fish-bearing streams.

Under the No Action Alternative, impacts on fish and aquatic habitat would remain low to nonexistent.

4.8.2 Options Common to All Alternatives

These component options and sub-options would have no to low overall impact on fish and aquatic habitat, with the exception of the gravel source, airstrip location and management, and regulation of angling.

Gravel Source

Siting gravel pits in the floodplain would cause some trapping of fish following flooding. During flood events, fish, especially juveniles, seek calmer water and often are found not only in tributary streams (Morsell, 2000), but also commonly in flooded riparian habitat. Fish could become trapped in gravel pits when a flood receded. In 1992, the Chena River Dam floodgates were closed to protect Fairbanks from flooding. After drawdown, substantial numbers of fish were found trapped in isolated ponds (Fleming, 1992). These pond-trapped fish would most likely be predominantly juvenile chinook and grayling. Because the majority of spawning and likely juvenile use in the river for both chinook and grayling occurs downstream of the proposed gravel pits, impacts to the populations should be low. Because movement patterns of young of the year fish within the river are unknown, however, and significant spawning occurs adjacent to and above the proposed gravel pits, impacts may be higher. These impacts could be mitigated, where feasible, by reducing the number and size of gravel pits, and by building perimeter berms around, and providing outlets to the Goodpaster River from, the gravel pits.

Air Access

- Airstrip Location The proposed location of the airstrip abuts an outside bend of the Goodpaster River. Outside bends are where erosion and bank failure normally occur during floods and high discharge. Impacts would arise from floods and bank erosion from airstrip clearing. The flooding of the airstrip then could lead to channel alterations and ensuing downstream sedimentation and possible loss of spawning and macroinvertebrate habitat. These impacts would range from low to moderate based on the severity, timing, and frequency of flood events. Erosion due to airstrip construction could have a major local impact if it occurred during salmon spawning.

  The USFWS recommended that to protect the airstrip from erosion and the river from sedimentation, considering the potential for contaminant migration toward the river, a 300-ft buffer should be maintained between the airstrip and the river. From the perspectives of local topography and flight safety, however, the airstrip location cannot meet both the 300-ft buffer recommendation and FAA runway alignment requirements. Mitigation and reclamation measures to maintain river bank stability are expected to prevent encroachment on the airstrip.

Use The level of impact from airstrip use would be related to management during and after the life of the mine. Impacts, which would arise directly from accidents involving either aircraft or fuel storage and routine spillage from refueling and indirectly from recreational use, would be minimal. The most restrictive management options would have low overall impact. During mine operations, direct impacts on fish and habitat would be low if access were limited to project needs only and proposed fuel storage and handling procedures were implemented. This management option would also result in minimal indirect impact. Overall impact could increase with access open to other commercial users because of increased traffic volume, but would still be low because indirect impacts would be minimal. Opening the airstrip to everyone would raise overall impacts to a low to moderate range because both direct and indirect impacts would increase because of increased traffic volume, use by the public not trained in fuel spill prevention and control, and recreational activities. Indirect impact would come predominantly from angling and, if necessary, could be mitigated through state regulatory authority.

Disposition At the end of the Pogo project, reclamation of the airstrip would essentially result in no impact to habitat, provided reclamation were successful, i.e., revegetated prior to a severe flood event. Impact from keeping the airstrip open for other users would be low if there were little industrial use, no fuel storage, and bank armoring was installed during mine reclamation. Recreational use impacts can be mitigated as discussed above.

Angling Indirect impacts to grayling and chinook salmon populations could arise from workers angling in their off hours and could be high. Catch-and-release grayling fishing can cause mortality rates above 10 percent (Clark, 1993), and are likely substantially higher for salmon exhausted at the end of a 1,000-mile journey. Although present regulations prohibit salmon angling, they must be enforced. Substantial portions of these populations migrate past the mine site during the course of the open water season. This potential impact would be mitigated because the Applicant intends to enforce a "no fishing" policy by workers (Hanneman, 2001).

4.8.3 Options Not Related to Surface Access

Alternative 2

All component options and sub-options for Alternative 2 would have no to low overall impacts on fish and aquatic habitat, with the exception of water discharge.

Water Discharge

Development Phase

- Underground injection wells As discussed in Section 4.2 (Ground Water), water injected at high rates would have a potential to surface in nearby sloughs. Estimated water quality under worst-case scenarios raises the possibility that mercury concentrations could frequently exceed by 10 times the aquatic life water quality criteria (Section 4.3, Water Quality). Given the potential of injected water to surface, there could be a high impact on fish and aquatic habitat in these sloughs. The nearest slough to the injection wells, however, is isolated from the main stem at all but high-flow conditions. Although sloughs with main stem connections are important habitat for salmonid fry, isolated sloughs are likely used only as refugia for all ages of salmonids during high-water events, and high water would dilute mercury concentrations. Thus, impact from injection wells under the worst-case scenario would be highly localized within the drainage. Mercury under these worst-case scenarios would be below acute concentrations to nonindigenous fish and aquatic invertebrates. Given the temporary use of the injection well (2 years) and the worst-case scenario, impacts on aquatic resources in the river would be low, localized, and short term.

Operations Phase

- Soil absorption system
    - Goodpaster River Valley Projected water quality of the treated discharge as it leaves the SAS and enters the ground water is expected to exceed water quality criteria for a number of parameters (Section 4.3.3). Ground water is critical for

incubation of fish eggs and for maintaining winter flows. Modeling the fate and transport of this discharge from the SAS, located in the Goodpaster floodplain prior to reaching the Goodpaster River, found that all but three parameters under maximum discharge rates and all but one parameter under average discharge rates meet water quality criteria. The increase in concentration for these parameters to the river likely would be small, due to attenuation and dilution, and limited to locations where ground water enters the river. Impacts to fish would be low and localized. Moderate impacts could be expected in a larger area in the short term if process upsets or facility failures were to occur, but these are highly dependent on timing and duration. Depending on where the ground water would reach the river, overall impacts to the aquatic resources of the river in the long term would be low to moderate, and would be localized.

- ✦ Above Pogo Ridge Locating the SAS above Pogo Ridge would provide more attenuation and dilution to the discharge prior to reaching the Goodpaster River. Thus, impacts to the river would be less than with siting the SAS in the floodplain. It is unknown, however, if the flow would remain subsurface or would surface in Easy Creek Valley. If flow surfaced prior to reaching the river, impacts would be similar to those described above.

- Underground injection wells Injection wells would be used only under special circumstances, such as during rehabilitation of the SAS, discharge of clean RTP water, or mine drainage discharge, all of which would occur only when advanced sampling for potential contaminants had shown that the discharge could meet injection limits for well water quality. Therefore, impacts would be low.

Alternative 3

All component options and sub-options for Alternative 3 would have no to low overall impacts on fish and aquatic habitat, with the exception of direct water discharge to the Goodpaster River.

Water Discharge

Development and Operations Phases

- Direct discharge to Goodpaster This option would use an underwater diffuser bar to discharge water to the river in a stable area below the exploration camp (Figure 2.3-1a). Habitat in this area is not suitable for fish spawning. The nearest spawning area is approximately 250 ft downstream of the discharge point (Morsell, 2001). As described in Section 4.3 (Water Quality), a minimum mixing ratio of 25 parts river water to one part discharge would create a mixing zone approximately 30 ft long and 15 ft wide. No discharge would occur during flows of less than 10 cfs (a 100-year event in late winter). The mixing zone would be sufficient to meet water quality standards at the edge of the zone for all parameters, except iron during high flows. This process would have a high impact on aquatic resources in the immediate vicinity of the diffuser pipe, and a low impact outside the mixing zone.

  The potential for process upsets and facility failure also must be considered during the life of the project. Given the right timing, duration, frequency, and volume, these upsets and failures could lead, over time, to bioaccumulation of metals in the local habitat far larger than estimated for the mixing zone. This bioaccumulation could alter benthic communities and distribution, growth, and survival of fish. Upsets also could cause disruptions in fish behavior relating to homing and habitat selection if the mixing zone reached bank to bank. Because the probable frequency of this combination of events is low and the dilution factor high, the impact to the aquatic resources in the river would be moderate and localized.

Alternative 4

All component options and sub-options for Alternative 4 would have no to low overall impact on fish and aquatic habitat, with the exception of on-site power generation and water discharge through an off-river treatment works.

Power Supply

- On-site generation This option would require transporting an additional 4.2 million gallons of diesel fuel annually to the mine site. This transportation requirement would substantially increase the risk of accidents and spills during transport and storage and could result in a moderate to high impact on local fish and aquatic habitat that could be temporally substantial to the chinook population if occurring during the low flows of winter or during spawning. This risk would be eliminated by using a power line to bring power to the mine site.

Water Discharge

Development and Operations Phases

- Off-river treatment works This option would have less impact to the river than a direct discharge because it would have an estimated 24-hour holding capacity following an upset, allowing mitigation measures to be taken. During an upset or low flows, the outlet pipe gate from the treatment pond would be closed and treated effluent would be stored in the RTP.

  Process failures, mine shutdowns, and environmental upsets such as severe winter weather and extended low flows could exceed RTP storage capacity and result in overflow into Liese Creek. If such overflow into Liese Creek were to occur, it would be expected in the spring after breakup in the Goodpaster, but before breakup in Liese Creek (Teck-Pogo Inc., 2002i). With Liese Creek frozen, as well as the wetlands it drains into, overflow would flow directly into the Goodpaster.

  A combination of process failures and environmental upsets, such as severe winter weather and especially flooding, would lead to localized impacts as described for the direct discharge option in Alternative 3, but would be less severe in the case of flooding because of dilution.

  Historical winter low flows in the Goodpaster River are approximately 40 cfs. Because the Applicant would maintain a flow in the river of at least 20 cfs during water withdrawal for the treatment works, and considering the 1,800-ft reach of the river that would be affected, there would be minimal to no impacts on fish.

  The primary pond would provide benefits because it would have slack water habitat that grayling fry and, during high water, juvenile salmon would use. It also would offer overwintering habitat. Some entrapment of juvenile salmonids would occur at the pumping station, but it would be minimal under the project design.

In severe floods, some entrapment of juvenile salmonids would occur in the secondary pond, but this entrapment would have a low impact on the overall population. Construction of gravel berms around the second pond could mitigate this impact.

Considering its storage capability, the low probability of the combination of upset events that would exceed this capability, and the unknown effects of severe winter weather on the process facilities, impacts to the aquatic resources of the river from the off-river treatment works would be low to moderate, and localized.

4.8.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- The Shaw Creek Hillside all-season road would have, overall, a low to moderate level of impact on fish and habitat, depending on the road use options permitted. The route would require six crossings of fish-bearing streams. Four of these streams, Caribou, Gilles, and Shaw creeks and the Goodpaster River, are known to have important fish habitat and substantial fishery resources. The level of direct impacts from this route would be related to road design, i.e., width, alignment, drainage, type of crossings, construction timing, and type and volume of traffic. Alignment and drainage would affect the amount of sediment and vehicle pollution (oil and other lubricant spills) entering the streams while crossing placement and type could affect erosion and blockages of fish movements. Road width and traffic volume would affect the probability of accidents spilling hazardous materials that, in time and place, could affect fish and aquatic habitat. Traffic volume and type also would determine the amount of routine vehicle pollution and risk of accidents.

  The Applicant proposes to minimize these potential impacts by siting a two-lane road in uplands above the wetland complex of the creek, aligning crossings perpendicular to all fish-bearing streams with the use of bridges, limiting traffic to project needs only, and instituting safety procedures during transport. Timing of construction at stream crossings, or other mitigation measures approved by ADFG, would minimize disruptions during spawning, especially for grayling and salmon. While construction activities and operation would affect some erosion and sedimentation even under BMPs, the overall impacts on fish and aquatic habitat would be low and localized.

  Accidents that spilled hazardous materials at or near stream crossings could have a high impact on fish, depending on time of year and drainage. For example, a hazardous material spill that found its way into Caribou Creek during May or June would have a major effect on the grayling population of the drainage through displacement of spawners and/or death of adult fish and eggs. A mid-winter spill, however, would have no impact at Caribou Creek because no fish are present then, but it would have a high impact at Gilles Creek, upper Shaw Creek, and the Goodpaster River because of low flows and overwintering fish. The risk of such accidents, however, is considered low for the majority of the route because of the proposed alignment location. Accident risk, however, would be higher in both drainages along the 18-mile segment that crosses the divide between the Shaw Creek and Goodpaster drainages.

- Richardson Highway egress Both Richardson Highway egress options would require crossing Rosa Creek. Other than this crossing, the Tenderfoot option is entirely in uplands and would have no impact on fish or aquatic resources. The Shaw Creek/Rosa egress option could require widening and straightening the present road that abuts wetlands and directly parallels the creek for a short distance, and would parallel Rosa Creek for approximately 1 mile. Overall impacts on fish from this option would be low

Use During mine operations, direct impacts on fish and aquatic habitat would be low if road use were limited only to the Pogo project or to Pogo and other industrial/commercial users. This option also would result in minimal indirect impact from angling at stream crossings. There would be no indirect impact if the Applicant's "no fishing" camp policy were extended to its employees using the road, as well as to employees of other industrial/commercial users.

Opening the road for public use would raise overall impact to a low to moderate range because both direct and indirect impacts would increase due to traffic volume and recreational activities. Indirect impacts would occur predominantly from angling and, on the Goodpaster River, boating. State regulatory authority, which is mandated to manage fishery resources for maximum public benefit, could mitigate angling impact through fishing regulations. This could result in length of season limits, as well as limits on size and methods of take.

There is presently no such authority to regulate boating on the Goodpaster, and use of an all-season road by everyone would increase the number of boats on the Goodpaster. The level of impact from boats would be highly dependent on type, use level, and river characteristics, and could thus range from minimal to moderate. Motorized boating during low flows would disrupt spawning behavior and dislodge and suffocate eggs. It also would affect water quality because of exhaust emissions and erosion, and could disturb riparian habitat by undercutting banks through wake action.

- Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. This option would eliminate impacts from angling and boating on the Goodpaster.

Disposition At the end of the Pogo project, the most restrictive access option, reclamation, would have minimal impacts to fish and aquatic habitat. The most liberal option, leaving it open for everyone, would have a low to moderate impact for the same reasons as discussed above for the operational phase.

Alternative 3

Surface Access

Route

- The South Ridge route would offer a lower risk to fish and habitat than the Shaw Creek Hillside all-season road because it would require only one stream crossing, the Goodpaster River. Thus, this route would potentially affect only one drainage, instead of two, as for Alternative 2.

Use This alternative would have minimal to low overall fish and aquatic habitat impacts within the range of management options, as discussed for Alternative 2.

Disposition Same as Alternative 2, except reclamation would still allow recreational access to the Goodpaster by ATVs because a cleared path would remain for some time following reclamation. Such access from the ridge to the upper Goodpaster Valley likely would result in erosion problems, as historical ATV use has shown.

Alternative 4

Surface Access

Route

- The Shaw Creek winter-only access would cause a moderate impact on fish and habitat. The route would cross at least five streams, two crossings of Shaw Creek, one of Caribou and Gilles creeks, and the Goodpaster River. It would be located in the lower Shaw Creek wetlands and then follow the same route over the drainage divide as the Shaw Creek Hillside all-season road. Impacts would arise almost solely from the risk of accidents at or near stream crossings. With 30 to 35 trucks a day for 50 to 60 days during mid-winter, hauling 800,000 gallons of fuel and 200 tons of cyanide per year, the relative risk of accidents would be high, especially on the steep 18-mile section over the divide between the Shaw Creek and Goodpaster drainages. An accident near the upper Shaw Creek or Goodpaster crossing would cause high impacts to overwintering fish during low flows of winter.

Use Winter-only access effectively would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2.

4.8.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts to fish and aquatic habitat.

- All-season Road Maintained Direct and indirect cumulative impacts on fish and aquatic habitat would occur from extraction of timber and mineral resources and increased recreational use from access opportunities and population growth. Erosion from roads, accidents, facility failures, environmental upsets, and recreational use all would alter habitat to some degree. While impacts could be minimal in any one occurrence, over time these impacts cumulatively would result in habitat loss and smaller, though still viable, fish populations. The brunt of this impact would fall on recreational users of the Goodpaster River through implementation of more restrictive regulations on fish harvest and possibly access.

  Additional mineral development beyond the proposed project would increase the risk of impacts by either extending the period of active mining, as under the scenario of finding additional reserves at Pogo or development of a hypothetical Sonora Creek mine, or simply by increasing the number of active mines, as under a hypothetical Slate Creek mine scenario. The latter would result in greater potential impacts than the former because access would cover an additional 25 miles of the Goodpaster River. The risks of upset from accidents and natural events in these scenarios would exist, but design, construction, and permitting stipulations, as well as State of Alaska management practices, could mitigate such risks to fish and aquatic habitat.

  Overall, cumulative impacts would be moderate, and would be high only locally.

4.9 Wildlife

In this section, potential wildlife impacts are discussed in the context of the wildlife populations and habitat in the Goodpaster River and Shaw Creek drainages and, where the home range of a species is large, in adjacent drainages.

Wildlife impacts address effects on wildlife itself as well as wildlife habitat. Two types of impacts are considered – direct and indirect. Direct impacts are those that directly affect animals (collisions with vehicles or power lines and physical barrier to movements) and habitat (direct elimination of habitat by construction of project facilities such as the airstrip, road, mill, and camp). Indirect impacts are the effective loss of habitat through avoidance because of human contact and associated activities and noise.

Attention in this section is focused on species that are generally considered of primary importance for ecological, aesthetic, subsistence, or recreational purposes. Threatened, endangered, and sensitive species are discussed separately in the following section (4.10).

Note that clearing is defined as removal of vegetation above ground level, but with no major damage to the vegetative mat on the ground surface. Surface disturbance is defined as major damage to, or removal of, the vegetative mat. And the word "disturbance" alone is used generically to include clearing and surface disturbance.

4.9.1 No Action Alternative

- **Habitat** Habitat disturbance from non-resource development in the project area would be minimal. Low-level development of residential and recreational cabin land, as well as some low-level commercial and industrial development, could occur within the Richardson Highway corridor, and would be commensurate with population growth. The NMDS would not be built within the project area, but construction of a natural gas pipeline and access roads would cause surface disturbance of between 300 and 400 acres parallel to the TAPS ROW within approximately 2 miles of the Richardson Highway. These activities would cause minor habitat loss in the context of the project area.

  Implementation of the DOF's 5-year harvesting plan in the Shaw Creek drainage and Quartz Lake/Indian Creek areas and the associated road development would affect wildlife habitat. Eight timber sales are planned that would disturb approximately 1,313 acres, not including new timber access roads (ADNR, 2002). Construction by DOF of roads into these areas over several years for ongoing timber sales would result in long-term timber harvesting within those units of the TVSF. These timber harvests would alter habitats and therefore species composition. If harvesting were done using BMPs in a manner that prevented degradation of the vegetative mat, however, and according to the principles of sustained yield management, such harvesting would result in low habitat loss in the context of the project area.

- **Birds** Direct habitat loss for birds would be low, except locally for timber harvest areas. Loss of forest habitat would cause a change in species composition, with forest-dwelling species being replaced by those preferring early stages of vegetative succession. Both the impacts to the former and benefits to the latter would be high only on a local basis. Indirect impacts would be minimal, even on a local basis.

- **Mammals** In the same manner as for birds, direct habitat loss for mammals would be low, except locally for timber harvest areas. Loss of forest habitat would cause a change in species composition, with forest-dwelling small mammal species being replaced by those preferring early stages of vegetative succession. Marten, however, are dependent on larger, homogeneous stands of mature spruce timber. If ongoing harvests were to fragment larger spruce stands, the forest fragmentation could have a high impact on marten in the context of the Shaw Creek drainage.

  For large mammals with large home ranges, these vegetative changes generally would have low impacts. If timber harvesting occurred at various locations across the Shaw Creek Hillside on an ongoing, regular basis, however, there likely would be benefits to some species. An increase in "edge effect," which would occur with timber harvesting in an otherwise homogeneous forest, is generally favorable to many species by interspersing different habitats within a smaller area. Vegetative succession following clearing would produce more deciduous species such as willow, which is a favorite moose browse. For moose, these benefits largely would be high only on a local basis, but if a dispersed timber harvest pattern of a thousand or more acres were to occur on the hillside within a 10- to 15-year period, the increased food supply for moose might be of substantial benefit on a greater than local basis.

  Indirect impacts would be minimal, largely related to timber harvest activities and to other uses, including recreational, of the all-season timber road system. Such indirect habitat loss likely would be high only on a local geographical and temporal basis.

  Overall, impacts from the No Action Alternative would be low, with both high impacts and high benefits occurring at a local level.

4.9.2 Options Common to All Alternatives

These common options are all located at the mine site.

- **Habitat** As a group, these options and sub-options would directly disturb approximately 383 acres of habitat, all in the mine site area. The large majority of disturbance would occur in the following habitat classes: upland needleleaf forest, upland mixed forest, lowland needleleaf forest, riverine needleleaf forest, and riverine mixed forest. No rare or uncommon habitat classes would be disturbed. Even within a local context, this direct habitat loss would be low.

  Most of the mine area disturbance would occur on medium-value Conservation Priority Index habitats, but nearly half of all disturbance in the airstrip area complex would occur on high-value habitats. This disturbance would cause a high impact only on a local basis, however.

- **Birds**

  Direct impacts These options and sub-options would not directly affect nesting or other important habitats for waterbirds or raptors.

  Direct impacts would occur to several passerine species whose small territories and home ranges fall within the footprints of these mine area components, particularly the dry tailings stack and RTP, the mill, and the camp. This loss would be high only on a local basis, however, because the habitat types are common in the Goodpaster drainage and throughout the Interior, and the species affected also are widespread.

Indirect impacts Indirect impacts for small passerine species would be negligible because the species would adapt to life adjacent to the facilities. There would be some minimal indirect habitat loss, primarily to predator species that would tend to avoid the activities associated with the mine area. Because the majority of their prey species such as small mammals (voles, shrews, and hares) and passerines likely would not experience much indirect habitat loss, these predators would experience only minimal indirect habitat loss, considering the relatively large areas within which they hunt. Thus, indirect habitat loss to birds would be low.

✦ **Mammals**

Direct impacts Direct impacts for large mammals (moose, caribou, wolf, and bear) would be small, given their large home ranges and the availability of suitable habitat in the Goodpaster drainage, and would be low even on a local basis. No critical habitat for these species occurs in areas to be cleared for these options.

Larger furbearers (lynx, coyote, red fox, wolverine, and martin) would experience some direct habitat loss, but given the size of their home ranges, impacts would be moderate and only on a local basis. For short-tailed and least weasels, direct habitat loss would be high only on a local basis. There would be no substantial direct habitat loss for largely water-dependent furbearers (river otter, beaver, mink, and muskrat) because these options would not directly affect water bodies or waterways.

Direct impacts would occur to small mammals (voles, shrews, and hares) whose territories and home ranges fall within the project footprint. This loss would be high only on a local basis because similar habitat is common in the Goodpaster drainage and throughout the Interior, as are the species that would be affected.

Indirect impacts Some indirect habitat loss for moose would occur because individuals generally would avoid the activities associated with the major facilities, but they likely would use suitable habitat in areas adjacent to project operations. Given the relatively large home range of this species and its ability to accommodate to some human activity, this indirect habitat loss would be high only on a local basis.

A longer term indirect impact to moose could occur. The Alaska Board of Game has adopted intensive management for the project area with the intent of increasing the number of moose for human consumption. The presence of the Pogo mine facilities and other possible mining activities, however, would cause a more conservative approach in wildfire suppression and likely would reduce the potential for increasing the number of moose near the mine area from favorable habitat changes caused by naturally occurring wildfires.

Based on recent movements of the Fortymile Caribou Herd (FCHPT, 2000), for the more critical period from May through September, caribou cows and calves likely would not be found in the vicinity of the proposed mine site. Only during the less critical October through April period of rut, early winter, winter, and early spring would some individuals on the edge of the herd's distribution be expected near the proposed mine site. Caribou are more sensitive to disturbance than moose, and individuals encountering the facilities and activities at the mine site likely would avoid the area to a much greater extent. Because of their substantially larger home range, and the current absence of other large human activity centers in the upper Goodpaster drainage, the indirect loss of habitat from avoidance of the mine area facilities would be low to caribou.

Wolves also would be subject to indirect habitat loss because they would avoid the mine area facilities. Like other large mammal species, because of their large home range, and because at present there are no other large human activity centers in the Goodpaster drainage, the indirect loss of habitat from avoidance of the mine area facilities would be low. Wolves using the den site in the vicinity of Indian Creek, however, likely would abandon the site as mine area and airstrip development occurred.

Both black and brown bears would experience some unpredictable level of indirect habitat loss. These losses would not be high, however, because of the large home ranges of the bears and the present lack of other large human activity centers in the area. Nonetheless, some bears would be displaced to other areas. Brown bears in particular have a low tolerance for, and seek to avoid, human activity. They would be affected to a greater extent than black bears, and the frequency of brown bear use in the vicinity of the proposed mine area would decrease. Black bears also would tend to avoid the area, but they are normally more accommodating to human activity than brown bears. Both species could be attracted to improperly handled garbage, which could result in their death. Both species are common throughout the Interior.

Water withdrawal from the RTP for mill operations during winter could produce conditions that could entrap large mammals, most likely moose. Water drawdown could produce ice shelves, voids with thin ice covering, or thin ice that might cause a moose attempting to cross the RTP to fall through and become injured or might preclude escape from the RTP. The number of moose that might be so affected would be quite small, however.

The dry-stack tailings pile, RTP, and the mill and camp complex would disrupt movement patterns of large mammals to some extent. Because these sites would not be fenced, some animals, most likely moose, would occasionally wander into these facilities. These animals usually would not be harmed, but probably would need to be herded out by project personnel. In unusual cases, the animals might have to be tranquilized and moved.

Indirect impacts for most smaller mammal species would be relatively minor because most would adapt to the presence of the facilities. Wolverine and marten, however, have a low tolerance for human activities, and indirect habitat loss for these species likely would occur in the vicinity of the proposed mine and some habitat fragmentation would occur. Because there are no other large human activity centers in the area, this loss would not be high in the context of the overall Goodpaster drainage throughout which these species are found.

The solid waste disposal facilities should be maintained in a manner that would not attract wildlife such as black bears. All putrescent wastes would be incinerated and the residual ash material buried. If these procedures were not rigidly adhered to or the prohibition against feeding of animals were not strictly enforced, however, bear-human contacts might occur that would result in serious injury to workers and the death of wildlife.

Removal of the airstrip at mine closure would allow the relatively high-value habitat to begin to recover through reclamation and plant succession. It also would reduce the indirect habitat loss by substantially reducing human activity in the area.

Gravel Source

Expanding existing gravel pits and developing new ones (including rock quarries), rather than crushing development rock for gravel, would cause surface disturbance to an additional approximately 66 acres in the vicinity of the mill and camp, and on the Goodpaster Valley floor below and south of the 1525 Portal and adjacent to the airstrip. If the off-river treatment works water discharge option were constructed (see Alternative 4 later in this subsection), approximately 13.1 acres (20 percent) of this total would be excavated for the two ponds, thus producing gravel that would be available for construction purposes.

With the exception of 4 acres of Conservation Priority Index high value habitat in the vicinity of the airstrip (discussed under Alternative 4 later in this subsection), disturbance generally would be to lower value habitat. And, if the gravel pits were reclaimed as ponds, habitat benefits would accrue. Still, mining gravel would have a moderate local overall habitat impact compared to crushing development rock for gravel.

4.9.3 Options Not Related to Surface Access

Alternative 2

Power Supply

- Power Line

  - **Habitat** Construction of a power line would require clearing vegetation on approximately 602 or 525 acres, depending on the route. This clearing would contrast with approximately 23 acres of additional disturbance required for diesel fuel storage tanks and laydown area for on-site power generation for Alternative 4. Power line clearing generally would not seriously damage the ground surface vegetative mat, however, and in a few areas, no clearing at all would be required because the existing natural height of vegetation would be too low to interfere with power line construction or operation. Thus, following clearing, the altered habitat would still provide support to wildlife, though of a different species composition.

  - **Birds**

    Direct impacts Construction of a power line would result in clearing vegetation on approximately 602 or 525 acres, and thus a direct habitat loss for birds. This habitat loss would affect species nesting on the ground and in low brush as well as forest-dwelling species because both brush and trees would be disturbed. Because of the narrow and linear nature of the disturbed ROW over a distance of approximately 43 miles, as well as its route across different habitats, these impacts would be high only on a local basis to most species. For larger species that may nest in some of the trees that would be removed (e.g., raptors), loss of some nest sites likely would occur. Because it is unlikely that nest trees are a limiting factor in raptor populations in the project area, loss of a few nests would not cause a high impact on more than a local basis because of the larger home ranges of these species.

    Bird-power line collisions Collisions with power lines and electrocutions cause millions of bird deaths annually in the United States. The power line option would pose a collision threat primarily to raptors and waterfowl, but could cause death to many smaller species. The degree of threat would be related to the size and design of the structures, the line (wire) profile, and the geographic location of the power line with respect to key habitats and flight pathways

The Applicant's proposed typical structure size and design would mitigate several concerns. In timbered areas, the approximately 70-ft height would mean the lines themselves likely would be below the tops of trees. The horizontal cross member H-pole construction would separate the lines by more than 15 ft laterally and substantially reduce the chance for electrocution. This design also would allow line wires to be strung on one horizontal plane rather than at different elevations vertically. In addition, phase wires would be of the same diameter, and no overhead ground wire is proposed for the lower geographic elevations nearer waterfowl areas. Wires would have daytime visual markers where they crossed Shaw Creek and the Goodpaster River.

Although there is little information about flight pathways in the project area, collisions might be reduced by use of daytime visual markers along more of the power line, especially at elevations above timberline where birds do not expect obstacles to free flight. Whether markers would be effective, however, is unknown, and such markers would increase risk of power line failure from wind and ice loads in these exposed areas. Overall, the project area is not likely a prime corridor for major bird movements, and collision impacts are expected to be high only on a local basis. There are likely to be differences in the probability of collisions between the two power line routes. These differences are discussed later for each alternative.

Indirect impacts Indirect impacts for all bird species would not be high. These option facilities are either passive in nature (e.g., the power line and water discharge facilities) or would be located within or immediately adjacent to other areas of activity (e.g., laydown area and fuel storage). Smaller species would adapt to nearby local activity disturbances, and while larger species with greater home ranges would tend to avoid areas of activity, the relatively small size of the facilities would not cause a high indirect habitat loss, considering the size of the species' areas of activity.

- **Mammals**

Direct impacts While not inconsequential in acreage, habitat impacts would be high only on a local basis to most small mammals and furbearers because the cleared power line ROW would be narrow and linear in nature, the ROW would cross different habitats, and the ground surface and vegetation would not be substantially disturbed. Because of their much larger home ranges, direct habitat loss would not be high for large mammals.

Clearing of the ROW could have advantages for some species. An increase in "edge effect," which would occur when the ROW were cleared through otherwise homogeneous forest, is generally favorable to many species by interspersing different habitats within a smaller area. Vegetative succession following clearing would produce more deciduous species such as willow, which is favorable to moose as browse. While favorable, because of the linear nature of the ROW, such benefits would be high only on a local basis.

Impacts from construction and use of temporary fuel storage tanks below the 1525 Portal and lower airstrip would be moderate to small mammals and only on a local basis.

Indirect impacts The power line and its ROW would be passive facilities, and would not cause any high indirect habitat loss during normal operation. When routine maintenance were required, or if an emergency were to occur, such activities could cause some indirect habitat loss, especially to larger mammals. Such activities would be infrequent and of limited duration, however, and would have a high impact only locally and within a short time frame.

The power line ROW could serve as an access corridor for ATVs into a presently remote, relatively inaccessible area, regardless of the road use status. If substantially increased access were to occur, the greatest wildlife impact likely would occur from increased use by moose, caribou, and bear hunters with a resulting increase in harvests for these species. More restrictive hunting regulations likely would be required to compensate for the increased harvests.

Water Discharge

- Soil Absorption System
  - **Habitat** A soil absorption facility for RTP discharge would cause surface disturbance of approximately 4.4 acres. If located in the Goodpaster Valley near the airstrip, this facility would be situated completely in Conservation Priority Index high-value habitat, and if located in the saddle above and southeast of the Pogo Ridge mill site, it would be situated in Conservation Priority Index low-value habitat. While impacts would be high only on a local basis at both locations, direct habitat impacts would be higher at the airstrip location. Location of the SAS southeast of Pogo Ridge, however, would substantially expand the footprint of the mine facilities and would have a greater indirect impact on wildlife.
- Underground Injection Wells Underground injection to an existing bored and cased well in the vicinity of the existing 1525 Portal would have low impacts on wildlife.

Alternative 3

Power Supply

- Power Line Same as Alternative 2.

Water Discharge

- Direct Discharge to Goodpaster A direct discharge to the Goodpaster River would cause surface disturbance to approximately 0.5 acre in a linear fashion. This disturbance would be a minimal impact.

Alternative 4

Power Supply

- On-Site Generation
  - **Habitat** On-site power generation would require an additional approximately 23 acres of disturbance near the airstrip for diesel fuel storage tanks and laydown area

to hold a full year's supply of fuel and supplies. There would be no additional disturbance needed for generators because a substation for the power line option would occupy the same area. This habitat loss would be moderate in the context of other surface disturbance at the airstrip complex. On-site generation, however, would avoid clearing vegetation on approximately 602 or 525 acres of power line ROW, as would occur with Alternatives 2 and 3, respectively.

On-site generation, however, would require moving an additional approximately 4.2 million gallons of fuel to the mine site during a short winter window. The transportation of fuel would pose a greater risk to wildlife and habitat from spills than would the power line option.

Water Discharge

- Off-River Treatment Works

  - **Habitat** This two-pond treatment facility would be constructed in approximately 13.1 acres adjacent to the airstrip. Excavated gravel would be used for project construction purposes.

    Approximately 4 acres of this facility would be in a Conservation Priority Index high-value habitat, generally mapped as uplands with a vegetation type of alluvial forests-terrace, a relatively common habitat type in the Goodpaster Valley. The location of the off-river treatment works facility was based on necessary proximity to the river, as well as avoidance of wetlands. Therefore, even if rock were crushed for aggregate, this would not avoid construction of the off-river treatment works. Although these 4 acres would be disturbed, the relatively common occurrence of this habitat type in the Goodpaster Valley would result in a low impact in the context of the Goodpaster Valley.

  - **Birds**

    Direct impacts The direct habitat loss for the off-river treatment works would be high only to small passerines and only on a local basis.

    Indirect impacts Indirect impacts due to activities associated with the off-river treatment works would cause little additional indirect habitat loss above that described earlier for the other mine area facilities, and would be moderate on a local basis. Noise from the diesel generators would have to meet OSHA standards and likely would cause only low indirect loss of habitat for birds.

  - **Mammals**

    Direct impacts The direct habitat loss for the off-river treatment works would be high only to small mammals and only on a local basis.

    Indirect impacts Indirect impacts due to activities associated with the off-river treatment works would cause very little additional indirect habitat loss above that described earlier for the other mine area facilities and would be moderate on a local basis. Although noise from the diesel generators would have to meet OSHA standards, this noise would add to the general noise level from other Liese Creek Valley facilities and would likely be more noticeable to mammals. This increased noise level could result in some small level of incremental avoidance by larger furbearers and large mammals.

4.9.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- Shaw Creek Hillside all-season road

  - **Habitat** This option would cause surface disturbance to approximately 770 acres, and construction of its companion power line would clear approximately 602 acres, for a total of approximately 1,372 acres (Table 2.3-6). Table 4.9-1 presents a breakdown of disturbance, by habitat type as shown in Figure 3.10-1, for each of the three surface access options. Table 4.9-1 also shows the disturbance that would occur to Conservation Priority Index habitats as shown in Figure 3.14-1.

    Three habitat types individually would compose more than 10 percent of the disturbed area: upland mixed forest (18 percent), upland needleleaf forest (18 percent), and lowland needleleaf forest (37 percent). Collectively, disturbance to these three habitats would constitute approximately 73 percent of all disturbances. From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (27 percent), medium-value (66 percent), and high-value (7 percent) habitats.

    Although the absolute total of approximately 1,372 acres of disturbance that would occur for the Shaw Creek Hillside all-season road and power line is large, it is small in the context of the project area. Also, the approximately 602 acres within the power line ROW would only be cleared, with little actual surface disturbance. The habitat loss for Alternative 2 would not be high for the following reasons: the linear nature of the corridors, the low impacts or absence of impacts on rarer or uncommon habitat classes, the abundance within the project area as well as in interior Alaska of the habitat types that would be primarily disturbed, and the low disturbance to Conservation Priority Index habitats.

Table 4.9-1 Acreage and Percentage of Surface Access and Power Line ROW Disturbance by Habitat Type and Conservation Priority Index Habitats[1]

	Alternative 2 Shaw Creek Hillside		Alternative 3 South Ridge		Alternative 4 Winter-Only Access	
Habitat Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Alpine meadow	10	< 1	21	1.6	10	< 1
Alpine dwarf scrub			16	1.2		
Subalpine needleleaf woodland	63	4.6	149	11.5	63	5.4
Cliff	< 1	< 1	1	< 1	< 1	< 1
Bluff meadow						
Upland tall scrub			102	7.9		
Upland needleleaf woodland	86	6.2	95	7.3	86	7.2
Upland broadleaf forest	27	1.9	249	19.3	22	1.9
Upland mixed forest	243	17.7	404	31.3	146	12.4
Upland needleleaf forest	254	18.5	96	7.4	219	18.5
Upland north-facing needleleaf forest	21	1.5	29	2.3	21	1.8
Lowland meadow			< 1	< 1	< 1	< 1
Lowland low scrub	6	< 1	< 1	< 1	24	2.0
Lowland broadleaf forest	74	5.4	7	< 1	38	3.2
Lowland needleleaf forest	501	36.6	45	3.4	483	40.8
Lakes and ponds	9	< 1	8	< 1		
Riverine barrens	1	<1			1	<1
Riverine scrub	1	< 1			< 1	<1
Riverine broadleaf forest	< 1	< 1				
Riverine mixed forest	6	< 1	< 1	< 1	3	< 1
Riverine needleleaf forest	30	2.2	21	1.6	28	2.4
Rivers and streams	38	2.7	19	1.5	37	3.1
Human modified	3	< 1	14	1.1	< 1	< 1
Cloud and shadow			16	1.3		
Total	**1,372**	**100**	**1,293**	**100**	**1,182**	**100**
Conservation Priority Index						
Low	373	27.2	416	32.2	357	29.9
Medium	908	66.2	843	65.2	795	66.6
High	91	6.6	17	1.3	42	3.5
Cloud and shadow			17	1.3		
Total	**1,372**	**100**	**1,293**	**100**	**1,194**	**100**

[1] Habitat types as shown in Figures 3.10-1 and 3.14-1.

✦ Birds

Direct impacts The Shaw Creek Hillside all-season road and power line would pass primarily through habitat of negligible value to trumpeter swans, with a few locations having low habitat value for swans. While the route would pass through or close to other waterfowl habitat in places, because the route is on the hillside, and not in the Shaw Creek Valley, it would have little effect on waterfowl habitat.

Direct impacts from the all-season road and power line on other species would be similar to those described earlier for a power line in Section 4.9.3 (Alternative 2), and would be high only on a local basis.

Bird collisions with power lines are discussed in Section 4.9.3 (Alternative 2). For this particular route, collisions likely would be lower than for the South Ridge alternative because for most of its route in the Shaw Creek Valley the power line would be within forest habitats. Collisions are expected to be of importance only on a local basis. The major area of concern, other than the crossings of Shaw Creek and the Goodpaster River, would be the approximately 10-mile segment located above timberline between the Shaw Creek and Goodpaster River valleys. If daytime visual markers on the lines were not used in this segment, bird collisions would be more likely to occur. There would be some collisions with road vehicles, primarily by small passerines, but these would have minimal impact.

Indirect impacts The indirect impacts would be the same as discussed in Section 4.9.3 (Alternative 2), and would not be high.

- ✦ **Mammals**

Direct impacts Direct impacts from this alternative would be high only to small mammals and only on a local basis.

Based on the low-, medium-, and high-value habitats presented for moose, caribou, and brown bear in Figures 3.14-3, 3.14-5, and 3.14-6, respectively, Table 4.9-2 presents, on a species basis, the acres and percentages of surface access and power line ROW surface impacts on these habitats for each alternative.

Except for a limited area of high-value moose habitat in the upper Rosa Creek and Keystone Creek drainages, the Hillside all-season road would traverse primarily medium-value moose habitat in the Shaw Creek Valley and low- or medium-value habitats over the Shaw Creek and Goodpaster River divide (Figure 3.14-3). A percentage breakdown of approximate overall moose habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (40 percent), medium-value (50 percent), and high-value (6 percent) habitats.

In a similar manner, the Hillside all-season road would cross primarily medium-value caribou habitat in the Shaw Creek Valley, and while climbing to and descending from the Shaw Creek and Goodpaster River divide. Along the top of the divide, however, this alternative would traverse approximately 6 miles of high-value habitat (Figure 3.14-5). A percentage breakdown of approximate overall caribou habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (28 percent), medium-value (63 percent), and high-value (5 percent) habitats.

For brown bears, which prefer more open, unforested habitats, the Hillside all-season road would traverse only low-value habitats throughout the length of the Shaw Creek Valley. While climbing to and descending from the Shaw Creek and Goodpaster River divide, the road would cross medium-value habitat. Along the top of the divide, however, this alternative would traverse the same approximately 6 miles of high-value habitat as for caribou (Figure 3.14-6). A percentage breakdown of approximate overall brown bear habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (45 percent), medium-value (44 percent), and high-value (7 percent) habitats.

For wolves, which move easily among many habitats as predators, relative habitat values are similar to those of their larger prey species, primarily moose and caribou, discussed above.

Table 4.9-2 Acreage and Percentage of Low-, Medium-, and High-Value Habitat Disturbance, by Species and Alternative, for the Surface Access and Power Line ROWs[1]

Species	Alternative	Habitat Value: Low		Medium		High		Negligible or Cloud/Shadow[2]	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Moose	2	550.4	40.1	690.6	50.3	83.9	6.1	47.7	3.5
	3	563.9	43.6	538.3	41.6	117.1	9.1	73.3	5.7
	4	413.9	35.0	682.4	57.8	38.6	3.3	46.8	4.0
Caribou	2	387.5	28.2	861.9	62.8	73.2	5.3	49.9	3.6
	3	783.8	60.6	264.2	20.4	185.2	14.3	59.5	4.6
	4	263.7	22.3	807.6	68.4	73.2	6.2	37.1	3.1
Brown bear	2	618.4	45.0	608.8	44.4	94.2	6.9	51.2	3.7
	3	73.2	5.7	945.5	73.1	214.5	16.6	59.5	4.6
	4	576.2	48.8	472.9	40.0	94.2	8.0	38.3	3.2

1 Based on Figures 3.14-3, 3.14-5, and 3.14-6.
2 Parts of satellite image obscured by clouds.

Because of the linear nature of the all-season road and power line corridors, the relatively small impacts of these corridors on the high-value habitats of these species, and the abundance of the potentially affected medium- and high-value large mammal habitats within the project area as well as in interior Alaska, the direct habitat loss from Alternative 2 would not be high for these large mammal species.

Collisions with all-season road vehicles would occur for both small and large mammals. Although the project area generally does not receive large snowfalls, the cleared road surface flanked by snow berms would be favored for movements by larger animals, particularly moose, when snow depths were high. Because of the small number of vehicles that would use the road under the Applicant's Proposed Project, this mortality would not be high even on a local basis.

If the road were open to other industrial/commercial users or open to everyone, traffic would increase proportionally, as would collisions. This increased mortality likely would be moderate only on a local basis. If the road were to remain open for use after mine closure, this mortality would continue.

Extending public access into new areas can result in changes to game population numbers from greater hunting success. Such changes can result in management restrictions such as hunting season length, animal size and sex restrictions, methods of take, and bag limits.

Indirect impacts Indirect impacts generally would be low for small mammals and certain larger species such as moose and black bear. Noise and activity would be limited to the narrow road corridor and individuals would adapt to these as they have to similar resource roads throughout interior Alaska. The Shaw Creek Hillside all-season road, however, would skirt and then enter a moose rutting area on the northwest side of Shaw Creek Valley. Except for the intense use of the road for a period during construction, the road-related noise and activity should have only a small effect on moose rutting.

Other species such as brown bears and wolverines, however, tend to avoid human activity and likely would avoid the area of the road corridor other than for crossing. The tendency to avoid the road corridor would not cause major habitat fragmentation for these species. For marten, however, a more wilderness species, the road corridor likely would serve as more of a behavioral barrier to movements and could cause some habitat fragmentation. Habitat fragmentation would be a low to moderate impact for this species.

- ✦ **Security gate at Gilles Creek** Impacts would be similar to those described above, except that public use would extend to only to the lower two-thirds of Shaw Creek Valley. This shorter road available to public use would lower collision mortality and reduce the area of easily accessible hunting.

Power Supply

- ▶ Power Line

  - ✦ **Route** In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide. This sub-option would have approximately the same habitat impact, but by consolidating the two corridors, as occurs for the large majority of the remainder of this alternative's route, it would remove almost all wildlife impacts from Sutton Creek with minimal additional impacts adjacent to the road.

Alternative 3

Impacts from this alternative generally would be the same as for Alternative 2 except as discussed below.

Surface Access

Route

- ▶ South Ridge all-season road

  - ✦ **Habitat** This option would cause surface disturbance to approximately 768 acres, and construction of its companion power line would clear approximately 525 acres, for a total of approximately 1,293 acres (Table 2.3-6). This disturbance would represent approximately 79 acres, or approximately 6 percent, fewer acres affected than for Alternative 2.

    Three habitat types individually would comprise more than 10 percent of the disturbed area: subalpine needleleaf woodland (12 percent), upland broadleaf forest (19 percent), and upland mixed forest (31 percent). Collectively, disturbance to these three habitats would constitute approximately 62 percent of all disturbances. Because the all-season road in this alternative would be located at a higher altitude than for Alternative 2, more upland than lowland habitat types would be disturbed, particularly upland broadleaf forest.

From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (32 percent), medium-value (65 percent), and high-value (1 percent) habitats. (Individual percentages do not total 100 because of cloud and shadow areas on aerial photographs.) This distribution would be relatively similar to that for Alternative 2, except that only 1 percent of disturbance by this alternative would be to high-value index lands in comparison to 7 percent for Alternative 2.

In the same manner as discussed for Alternative 2, while the absolute total of approximately 1,293 acres of disturbance that would occur for the South Ridge all-season road and power line is large, it is small in the context of the project area, and the area within the power line ROW would only be cleared. Because of the linear nature of the corridors, the low level or absence of impacts on rarer or uncommon habitat classes, the abundance of the habitat types within the project area as well as in interior Alaska that would be primarily disturbed, and the low disturbance to Conservation Priority Index habitats, the habitat loss for Alternative 3 would not be high.

- **Birds**

Direct impacts Direct impacts generally would be the same as for Alternative 2. Because the South Ridge all-season road and power line route climbs relatively quickly to altitude, and only passes through habitats of negligible value to trumpeter swans and waterfowl, they would not have high impacts on these species.

Bird collisions in general with the power line for this alternative likely would be higher than for the Shaw Creek Hillside alternative because for approximately 25 miles the power line would be above timberline along the South Ridge. If daytime visual markers on the lines were not used in this segment, bird collisions would be more likely to occur.

Indirect impacts Same as Alternative 2.

- **Mammals**

Direct impacts As with Alternative 2, direct habitat loss from this alternative would be high only to small mammals and only on a local basis.

The South Ridge all-season road leaves the lowlands soon after leaving Quartz Lake and climbs to and follows the crest of the Shaw Creek and Goodpaster River divide, unlike the Hillside all-season road, which traverses lowlands for the length of the Shaw Creek Valley before crossing the divide. This altitude difference primarily accounts for the differentiation in habitat impacts between these two alternatives.

The South Ridge all-season road would traverse primarily low- and some medium-value habitats throughout its length. For approximately 5 miles along the crest of the divide, however, just before this route joins with the Hillside all-season road route, this alternative would pass through or adjacent to high-value moose habitat (Figure 3.14-3). A percentage breakdown of approximate overall moose habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (44 percent), medium-value (42 percent), and high-value (9 percent) habitats. This disturbance would be approximately 50 percent more high-value habitat than for Alternative 2.

This alternative would cross primarily low-value caribou habitat for most of its route before joining with the Hillside all-season road route. For a distance of approximately 3 miles on the divide, however, in the vicinity of Shaw Creek Dome, this alternative would traverse high-value caribou habitat (Figure 3.14-5). A percentage breakdown of approximate overall caribou habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (61 percent), medium-value (20 percent), and high-value (14 percent) habitats. While this alternative would cross more than twice as much low-value habitat as Alternative 2, it also would cross almost three times as much high-value habitat as Alternative 2.

For brown bear, this alternative would cross or be immediately adjacent to medium- and high-value habitats for its entire length, including an approximately 5-mile segment of high-value habitat along the crest of the divide in the vicinity of Shaw Creek Dome (Figure 3.14-6). A percentage breakdown of approximate overall brown bear habitat disturbance for this alternative (Table 4.9-2) shows disturbance would occur in low-value (6 percent), medium-value (73 percent), and high-value (17 percent) habitats. Thus, this alternative would cross a substantially greater distance of medium-value habitat than would Alternative 2, and 2 ½ times the distance of high-value habitat.

The relative disturbance to wolf habitats would be similar to that for Alternative 2.

Because of the linear nature of the all-season road and power line corridors, the relatively small impacts of these corridors on high-value habitats of the species discussed above, and the abundance of the potentially affected medium- and high-value large mammal habitats within the project area as well as in interior Alaska, the direct habitat loss impacts from Alternative 3 would be the same as for Alternative 2, and would not be high for these large mammal species. This alternative, however, would disturb roughly twice the acreage of high-value habitats for moose, caribou, and brown bear than would Alternative 2.

Vehicle collision mortality would the same as Alternative 2.

Indirect impacts Indirect impacts generally would be the same as for Alternative 2. This alternative, however, would avoid the moose rutting area in Shaw Creek Valley, and its long run above timberline along the Shaw Creek and Goodpaster River divide would not pose the same habitat fragmentation concern for marten as would Alternative 2.

Alternative 4

Because the Shaw Creek Flats winter-only access route follows the Shaw Creek Hillside all-season road route, except for the first approximately 15 miles in lower Shaw Creek Valley, the impacts of this alternative would be similar to those of Alternative 2, except in lower Shaw Creek Valley.

Surface Access

Route

- Shaw Creek Flats winter-only access
  - **Habitat** This option would cause surface disturbance to approximately 594 acres (Table 2.3-6). This disturbance would represent approximately 176 fewer acres

affected, or approximately 23 percent less, than for the Shaw Creek Hillside all-season road in Alternative 2. It would represent a similar approximately 174 fewer acres affected, or 27 percent less, than for the South Ridge all-season road route in Alternative 3. Because a major portion of the Shaw Creek Flats winter-only access segment of this option already exists as winter trails/roads, approximately 44 acres of predominately wetlands have already been cleared of larger vegetation.

Because of its similarity to the Shaw Creek Hillside route in Alternative 2, this alternative would primarily affect the same three habitat types: upland mixed forest (12 percent), upland needleleaf forest (18 percent), and lowland needleleaf forest (41 percent). Collectively, disturbance to these three habitats would constitute approximately 71 percent of all disturbances.

From the Conservation Priority Index perspective, approximate disturbance percentages would be low-value (30 percent), medium-value (66 percent), and high-value (4 percent) habitats. This distribution would be relatively similar to that for Alternative 2, except that only 4 percent of disturbance by this alternative would be to high-value index lands compared with 7 percent for Alternative 2. This lower disturbance to high-value index lands is largely because Alternative 2 would traverse approximately 85 acres of high-value index lands compared with only approximately 37 acres for Alternative 4.

✦ **Birds**

Direct impacts The Shaw Creek Flats winter-only access traverses habitats of low and high value to trumpeter swans in the southern half of the Shaw Creek Valley. Likewise, much of this area is important waterfowl habitat. Because of the temporal nature of winter trail construction, however, direct habitat loss for these species would not be high.

Because this alternative would use the same power line route as Alternative 2, direct impacts from the power line would be the same as for Alternative 2. Road vehicle collisions with birds would be fewer because of the limited window of activity, and because very substantially fewer birds would be present at that time.

Indirect impacts Because the winter-only access would be constructed and used only in winter, when the large majority of bird species would be absent, this alternative would cause minimal indirect habitat loss.

✦ **Mammals**

Direct impacts Direct habitat impacts on caribou and brown bears would be very similar to those for Alternative 2. For moose, however, this alternative would cross approximately 54 percent less high-value habitat than would Alternative 2 (Table 4.9-2). Like Alternative 2, however, direct habitat impacts would not be high.

Vehicle-wildlife collisions would be more likely to occur because of substantially greater winter traffic, especially if deep snow were to accumulate and cause animals to use the road surface for movements. These indirect impacts, however, would be locally low to moderate, depending on the particular winter.

Indirect impacts Indirect impacts would be very small for approximately nine months of the year when surface access to the mine site would not occur. During winter-only access construction and use, however, vehicle noise and activity levels would be very high. This would cause disturbance to moose, and caribou if they were in the vicinity, at a critical time (mid- and late winter) when energy reserves are low.

Winter-only access effectively would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2.

4.9.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would reduce resource development and related direct and indirect cumulative impacts on wildlife considerably, particularly caribou.

- All-season Road Maintained

  - **Habitat**

Non-resource development The mine-induced increase in population in the Delta area of approximately 260 to 350 for an all-season road could accelerate development of private residential lands in the Shaw Creek, Tenderfoot, Richardson Highway, and Quartz Lake areas, as well as some low-level commercial and industrial development within the Richardson Highway corridor. The associated habitat disturbance, including new roads and residential and commercial power line ROWs, could be high on a limited local basis in these areas if such development were concentrated. Impacts would be low on a greater than local basis. Winter-only access would induce an increase in population of only a third to a half that for the all-season road. Residential development and associated habitat disturbance from this option likely would low.

Timber More planned state timber sales, on a faster schedule, would occur on the Shaw Creek Hillside with a Pogo-related all-season road than if DOF were to incrementally construct its planned all-season forestry road over a period of years. Over the long term, however, the amount of timber removed from the hillside likely would not differ substantially between these scenarios. Cumulative habitat disturbance on the Shaw Creek Hillside, therefore, likely would not differ substantially from that for the No Action Alternative.

Because construction of the proposed DOF forestry road for the area that would be accessed by a Pogo-related South Ridge all-season road would occur further in the future, building the South Ridge all-season road would provide accelerated access to state timber resources and likely result in harvesting on a faster schedule.

The winter-only access option also would accelerate Shaw Creek Hillside timber sales, but to a lesser degree than would an all-season road because of the seasonal nature of the access, and because of competition with mine-related traffic during the limited window for winter use. Long-term impacts of habitat disturbance to the Shaw Creek Hillside from this option also would not differ substantially from those for the No Action Alternative.

Both an all-season road option and the winter-only access option, however, would provide access to other timber resources near the head of the Shaw Creek drainage, in the mid-Goodpaster River drainage, or in both drainages. An all-season road would provide considerably greater flexibility than would winter-only access. If long-term timber harvests were to occur in these areas over time with the use of BMPs in a manner that prevented degradation of the vegetative mat, and according to the principles of sustained yield management, such harvesting would have a low impact in the context of the project area. For some species, such as moose, timber harvesting can be beneficial because of favorable browse conditions during early plant succession.

Mining An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body could cause disturbance to an additional approximately 20 acres. This additional disturbance would cause relatively few additional cumulative impacts because most of the existing infrastructure would still be used.

An access road to the hypothetical Sonora Creek mine from the Pogo mine site would cause surface disturbance to approximately 75 acres, and the mine area facilities would cause surface disturbance to another approximately 50 acres. This combined disturbance would not affect any rare or uncommon habitats, and would be high only on a local basis. A power line extension from Pogo, largely above timberline at this altitude, would cause little habitat disturbance.

A hypothetical Slate Creek mine road would cause surface disturbance to approximately 240 acres, and the mine area facilities would cause surface disturbance to another approximately 220 acres. This combined disturbance likely would not affect any rare or uncommon habitats, and would be high only on a local basis. A power line extension up the Goodpaster Valley floor likely would require clearing a ROW through several stands of white spruce. This clearing would have habitat impacts similar to those discussed earlier for the power line to Pogo, and these impacts would be high only on a local basis.

An all-season road extending an additional 32 miles from the Pogo Mine to such a hypothetical Slate Creek mine in the headwaters of the Goodpaster River, however, would cause habitat disturbance substantially deeper into this area of the Yukon-Tanana Uplands. It also would increase the feasibility of other mining projects in the area. While the actual acreage of disturbance for this hypothetical mine would be small and would be high only on a local basis, this greater area of disturbance would enlarge the overall area subject to the beginning of habitat fragmentation through development and other human activities. Although this habitat fragmentation could have some effects on several species, it likely would be of most concern to caribou.

A likely effect of increasing mineral exploration and development activity would be harassment of wildlife by aircraft, both intentional as well as unintentional, particularly by low-flying helicopters. In combination with general, nonmineral-related aviation and the USAF aerial combat training, these activities could substantially increase cumulative impacts on caribou. Of particular concern is disturbance of the Fortymile Caribou Herd during its critical calving period.

✦ Birds

The direct and indirect impacts to birds from development of hypothetical mines at both Sonora and Slate creeks would be small and similar to impacts discussed earlier for an all-season road and power line to the Pogo Mine. Relatively little direct habitat loss would occur, and much of that would be linear in nature.

Extension of the power line would represent a small addition to the network of power lines slowly being built throughout the Interior, and would incrementally increase the cumulative impacts of bird strikes.

✦ **Mammals**

The direct impacts to mammals from development of hypothetical mines at both Sonora and Slate creeks would be low and similar to impacts discussed earlier for an all-season road and power line to Pogo. Relatively little direct habitat loss would occur, and much of that would be linear in nature. There would be some cumulative effect of such habitat loss, however, that would reduce wildlife numbers and diversity within the project area.

Indirect impacts could be somewhat greater because extension of an all-season road to the head of the Goodpaster River Valley cumulatively would increase human noise and activity levels, particularly affecting brown bears, marten, and wolverines, which have a tendency to shun human activity and would tend to avoid the area. In light of a history of roads creating more roads in interior Alaska, this road extension could begin habitat fragmentation for these species in the middle and upper Goodpaster Valley. With time, this habitat fragmentation could create cumulative impacts for these species, and for caribou.

Caribou The cumulative impact of direct loss of caribou habitat from development of a hypothetical Sonora Creek mine would be low. Recent movements of the Fortymile Caribou Herd (FCHPT, 2000), for the more critical period from May through September, have shown that caribou cows and calves likely would not be found in the vicinity of the proposed mine site. Only during the less critical October through April period of rut, early winter, winter, and early spring would some individuals on the edge of the herd's distribution be expected near the proposed mine site. Because of the very large home range of the caribou, and the current absence of other large human activity centers in the upper Goodpaster drainage, development of a hypothetical Sonora Creek mine itself would cause a small, incremental loss of indirect habitat for caribou, considering its location relatively close to the proposed Pogo Mine. In conjunction with the Pogo development, however, a hypothetical Sonora Creek mine would definitely cause a cumulative impact within the Pogo claim block.

An all-season road and power line from the Richardson Highway to the Pogo Mine would bring year-round human activities to, and begin the habitat fragmentation process at, the fringe of the recent annual range of the Fortymile Caribou Herd. An extension of these facilities to a hypothetical Slate Creek mine in the upper Goodpaster River Valley, with corresponding mine development, however, would expand year-round human activities and push the perimeter of habitat fragmentation to the edge of the herd's present summer range (Figure 3.14-4) (FCHPT, 2000).

While extension of an all-season road from the Pogo Mine to Slate Creek and development there of a new stand-alone mine would result in more cumulative direct loss of caribou habitat, this habitat loss in itself would not be high, given that a major portion of the loss would be road-related and linear, as well as in the Goodpaster Valley bottom, as opposed to the more important alpine caribou habitat.

The cumulative impacts of indirect habitat loss, however, would be more problematic. Caribou generally are sensitive to new development and human activities, and a

Slate Creek mine would be well inside the edge of the herd's recent annual range, except during the key calving and post-calving period of May and June when the herd is usually well to the east (FCHPT, 2000). During the remainder of the year, however, caribou would avoid the mine facilities and human activities within that portion of their traditional recent range. In the context of the herd's entire annual range, this development in and of itself likely would not constitute a high impact; however, it would definitely have a cumulative impact.

Based on the existing TBAP, which would retain this area in public ownership, caribou habitat fragmentation is not likely to occur because of direct habitat loss, but rather would be more likely to occur from indirect habitat loss. Thus, although a road extension from Pogo to Slate Creek and subsequent mine development would not in and of themselves likely cause high cumulative indirect loss of habitat, habitat fragmentation could occur in conjunction with other indirect habitat loss that could occur if other road extensions and developments were to happen,. It is not possible to predict the degree of cumulative indirect habitat loss with any certainty because further road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative indirect impacts would be very likely.

4.10 Threatened, Endangered, and Sensitive Species

No federal or state-listed threatened or endangered plant or animal species are known or expected to occur in the project area (Burgess and Ritchie, 2000). Because of limited suitable nesting habitat in the project area, no high impacts would occur to the American peregrine falcon or bald eagle. The following discussion, therefore, pertains to the sensitive species identified in Section 3.15 as being found in the project area, including the American Peregrine Falcon.

4.10.1 No Action Alternative

The impacts to sensitive species from the No Action Alternative would be related to the DOF's planned timber harvests in the TVSF, and would be similar to those discussed in Section 4.9 (Wildlife).

4.10.2 Options Common to All Alternatives

These mine area options could have some effect on all of the identified species.

A peregrine falcon nest site near the confluence of Indian Creek and the Goodpaster River is located less than a mile from the northeast end of the proposed 3,000-ft airstrip in the Goodpaster Valley. This site had an active, though unsuccessful, peregrine nest in 1998, but was unoccupied in the other 6 years from 1994 through 2000, inclusive. Surveys have shown that most other nest sites in the project area have been active during the same period, indicating that the Indian Creek site may be more marginal nesting habitat.

The activity that would be associated with construction and operation of the airstrip might cause indirect habitat loss if this nest site were to otherwise remain unused for the duration of the mine project. If the site were abandoned due to project activity, it would constitute a high impact within the context of approximately 18 miles of the upper Goodpaster Valley between Central Creek and the Glacier and Rock creeks area. It would not constitute a high impact, however, within the context of the project area as a whole. Because there would be no direct habitat disturbance to the nest site, at mine closure the site again would be available for nesting.

Three bald eagle nests were identified within the project area, all on the Goodpaster River. Two are located more than 12 miles downriver from the mine site, but one recently active nest is located approximately 3 miles upriver from the northeast end of the proposed 3,000-ft airstrip. Because the nest tree is located around the bend from the proposed airstrip site, relatively little project noise or activity would be discernable other than aircraft activity.

It is not possible to predict whether project construction and operation would cause abandonment of the nest site. There appears to be other suitable nesting habitat along the Goodpaster River (Burgess and Ritchie, 2000), and a number of bald eagle nests occur along the Tanana River between the Goodpaster River and Shaw Creek (Ritchie and Rose, 1999). If the site were abandoned due to project activity, it would constitute a high impact within the context of the upper Goodpaster Valley, but not within the context of the project area as a whole. Because there would be no direct habitat disturbance to the nest site, at mine closure the site again would be available for nesting.

The location of the construction camp, mill and campsite, and dry-stack tailing pile avoids the locations of identified northern goshawk nests, which are at least 1.5 miles from mine facilities and located in different drainages. The noise and human activity might cause abandonment of one or two nests for the duration of the mine project. Because of the abundance of goshawk habitat in the middle and upper Goodpaster Valley, as well as throughout the project area, this nest abandonment would be of only local importance.

Harlequin ducks could be displaced up or down the Goodpaster River during construction and operation of the mine facilities. This displacement likely would affect only a few individuals, would be limited to the project's duration, and would be of only local importance, given the availability of harlequin habitat throughout the rest of the middle and upper Goodpaster Valley.

In the mine area, olive-sided flycatcher territories were found in lower Pogo Creek and middle Liese Creek valleys. The Pogo Creek territory would not be directly affected by project construction or operation, but might be indirectly affected by noise and other activities. Given the small territory of this species, it is unlikely this territory would be abandoned. The territory in Liese Creek Valley, however, is south of the creek on the north side of Pogo Ridge, in the vicinity of the proposed entrance to the 1875 Portal. This territory could be directly affected, causing abandonment. If it were abandoned, it would constitute a high impact only on a local basis because of the availability of similar habitat throughout the Goodpaster Valley.

While lynx do tolerate human activity, they tend to avoid it. Mine-related activities likely would cause lynx to avoid the mine area for the project's duration. Given the size of the home range of this species, such avoidance would be moderate and only on a local basis.

4.10.3 Options Not Related to Surface Access

Power Supply

- Power Line The only non-access related option that could affect any of these species would be bringing power to the mine by power line in Alternatives 2 and 3. Construction of a power line could cause the loss of some raptor nest sites, depending on the route. This potential loss of nest sites is discussed below in Section 4.10.4 for each route option.

Bird collisions with power lines were discussed in general in Section 4.9.3 (Alternative 2), including mitigation measures to reduce such collisions. Because portions of both routes would traverse forested habitats, there would be a risk of collision for northern goshawks. This risk of collision is discussed below in Section 4.10.4 for each route option.

4.10.4 Options Related to Surface Access

The only sensitive species for which different impacts could be expected between access related alternatives would be the northern goshawk. While peregrine falcon nesting occurs on the bluffs north of the Richardson Highway near Shaw Creek Road, these sites have been exposed to traffic for many years. Any increase in traffic attributable directly or indirectly to the Pogo project is expected to have a low impact on such nest sites and the birds inhabiting them. For the other sensitive species, there likely would be no meaningful differential impacts.

For these other sensitive species, no high impacts would occur from any of the three alternatives either because important habitats would not be affected (peregrine falcon, bald eagle, and harlequin duck) or because construction and operation of the narrow, linear access and power line routes through large areas of suitable habitats would have relatively minor direct or indirect impacts (olive-sided flycatcher and lynx).

Alternative 2

Surface Access

Route

- Shaw Creek Hillside all-season road It is possible that some nest trees could be removed when clearing the ROWs. Northern goshawks nests along the access routes have been surveyed, and the Shaw Creek Hillside road and power line route would be in close proximity to three nests that were determined to be active in 1999 and 2000. Because it is unlikely that nest trees are a limiting factor in raptor populations in the project area, and because medium- and high-value goshawk habitat is found throughout the project area, loss of a few nests would not constitute a high impact on more than a local basis because of the larger home ranges of this species.

Alternative 3

Surface Access

Route

- South Ridge all-season road This road and its associated power line, would traverse only high-value goshawk habitat for virtually all of its route from the Quartz Lake area until shortly before it joins the Shaw Creek Hillside all-season road route on the Shaw Creek and Goodpaster River divide.

  This route would be close to one nest that was determined to be active in 1999 and 2000. Impacts from this alternative would be similar to those for Alternative 2, but likely would be somewhat larger because of the substantially greater distance of high-value habitat that would be crossed. Still, direct and indirect impacts would not be high on more than a local basis.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter-only access This route would have impacts similar to those for Alternative 2, but they would be lower in lower Shaw Creek Valley because the winter-only access segment of the route would pass through less timbered habitat.

4.10.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human access. There would be no cumulative impacts on threatened or endangered species, and no or low cumulative impacts to sensitive species.

- All-season Road Maintained There would be no cumulative impacts on threatened or endangered species. Cumulative impacts on sensitive species would be low in the context of the project area, but some impacts would occur. The combined DOF timber sales and the Pogo-related clearing for surface and power line access, as well as for mine area facilities, would reduce available habitat. For sensitive species with broad habitat requirements, such impacts would be small. For species with more specific habitat requirements, the impacts could be greater. For example, although a hypothetical Sonora Creek mine would have almost no incremental cumulative impacts on peregrine falcons, bald eagles, or harlequin ducks, the extension of an all-season road from Pogo up the Goodpaster River Valley to a hypothetical Slate Creek mine would. The more specific habitats of these species would be closely approached or paralleled by such a road, at the mouths of Indian Creek, Rock Creek, and all along the Goodpaster, respectively. While there would be no direct habitat loss, indirect habitat loss would be possible.

  As stated in Section 4.9, it is not possible to predict the degree of cumulative indirect habitat loss with any certainty because further road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative impacts would be very likely.

4.11 Socioeconomics

Analysis of the socioeconomic impacts of the Pogo project differs from other resource analyses in this document because there are few specific options for which a measurable difference in impact would be expected. This is because socioeconomic impacts and benefits result from whether or not the project as a whole proceeds, and not from which particular options are selected. An exception is whether surface access would be by an all-season road or winter-only access. Therefore, in this section, the impacts discussions are not grouped under specific options, but rather treat the project more in its entirety.

4.11.1 No Action Alternative

✦ Delta Area Employment and Unemployment

Employment in the Delta area is expected to change in response to two key forces: the construction and operation of the NMDS and the construction of the natural gas pipeline. After declining to and leveling off at approximately 720 jobs as a result of base downsizing (including the remaining 22 base personnel), Delta area employment is likely to start climbing again as construction of the NMDS begins. The NMDS construction labor force would average 400 workers for a 3-year period, pushing Delta area employment to 1,150 (not including the self-employed).

Once operational, the NMDS would directly employ an average of approximately 150 workers on a permanent basis (ADOL, 2002). The indirect and induced employment resulting from NMDS operations is expected to be small. Indirect jobs would be created as a result of local spending by the military on goods and services in support of system operations. Induced jobs would be created as a result of NMDS personnel spending their payroll dollars locally. Because the Delta area service and support infrastructure is not well developed, nearly all NMDS service and supply requirements would be met through Fairbanks or other urban areas. Assuming a multiplier of 1.2 (meaning that for every NMDS job, 0.2 additional jobs would be created locally in the support sector), 30 additional jobs would eventually be created in the Delta area. It is important to understand that this is an estimate only. No detailed research has been conducted on the potential socioeconomic impacts of the NMDS on the Delta area.

With a permanent employment impact of approximately 180 jobs (direct, indirect, and induced employment), total Delta area employment would level off at approximately 900 jobs, perhaps by 2005 or 2006, depending on continued NMDS development. Of course, while development has begun, completion of NMDS development is not a certainty, and without it, local employment could be expected to remain at approximately 720 jobs.

Construction of a natural gas pipeline through the Delta area could also create temporary employment opportunities for local people. The economic impacts of pipeline construction, which have not been quantified, likely would occur concurrently with NMDS construction.

✦ Delta Area Population

With development of the NMDS, the population will rise, first during a construction phase, then during normal operations. During construction, employment is expected to average 400 jobs, with a peak of 500. Because of the duration of the construction effort (3 years) the local population impact could be somewhat higher than for the typical construction project. Still, most of the construction labor force would be nonlocal and would be housed on site.

Total NMDS-related population (including employees and their dependents) is expected to be approximately 300 residents. Although no specific data is available, the indirect and induced effects are likely to be small, generating approximately 50 additional residents. This addition of residents would bring the total NMDS population impact to approximately 350 residents.

It is also possible that gas pipeline construction could occur during construction of the NMDS. At this time, it is not possible to predict what the local employment and population impacts of pipeline construction might be. Suffice to say, after a period of decline due to base realignment, the Delta area could be the scene of substantial, temporary construction-related economic activity due to construction of both the NMDS and gas pipeline.

Construction and operation of a prison in the Delta area is not considered as viable and has not been considered for the No Action Alternative.

In summary, for the No Action Alternative, Delta area population is expected to increase as NMDS development continues. An influx of nonlocal construction workers will occur as NMDS construction continues and if pipeline construction were to occur. This construction-related boom would occur over several years (depending on the timing of the projects). It is very difficult to predict what the permanent, local population, and economic impacts of this construction boom might be, and no research has been conducted on the subject, either as part of NMDS EIS or pipeline impact assessments.

As of 2002, the Delta area population stood at between 1,700 and 1,750 residents, according to the ADOL. The addition of 350 NMDS-related residents would push the area total to near 2,100 residents.

✦ **Delta Area Income**

In the No Action Alternative with development of the NMDS, per capita income for the Delta area should start increasing again. The degree of that increase would depend on the number of local people employed in the NMDS project and their income from those jobs. Similarly, to the extent that local workers participate in the construction of a gas pipeline, an increase in local income levels could result.

Income changes due to NMDS or the gas pipeline would be expected to occur in the Delta Junction and Big Delta areas. Predicting the magnitude of those changes is beyond the scope of this analysis. No change in per capita income would be expected in the Healy Lake area for the No Action Alternative.

✦ **Delta Area Public Services**

The Delta area is experiencing socioeconomic dislocation as a result of base realignment. The long-term effect of base closure on services provided by the City of Delta Junction is unclear. To the extent that there is decline in the nonmilitary population, population-based revenues, such as municipal assistance and state revenue sharing, could decline. This drop in revenue could affect the city's ability to provide basic services, such as road maintenance, emergency services, and community hall operations. Development of the NMDS could partially offset any long-term decline due to realignment and mitigate any potential long-term affects on local public services.

✦ **Delta Area Housing**

According to the 2000 Census, the Delta area housing stock, including Delta Junction, Big Delta, and Fort Greely, totaled 1,008 units in 2000. Approximately 60 percent of these housing units were occupied (603 units). Among the unoccupied units, 81 are for seasonal, recreational, or occasional use. Of the 324 remaining vacant housing units, 228 are at Fort Greely.

The housing demand spike created by the NMDS construction-related population is temporary and should begin easing in 2004. The construction effort is expected to peak at 500 workers. The availability of military housing as well as construction camp housing will determine the impact on the local housing market as employment scales up.

The long-term housing situation is uncertain. At this point, it is unclear what the final personnel requirements will be for NMDS operations (the scale of the development itself has been, and is likely to continue to be, subject to revision). According to the most recent published information (ADOL, 2002), 150 personnel will be required to staff the Fort Greely facility, including 50 military and 100 civilians. The total NMDS-related population of approximately 350 residents would require approximately 105 housing units (based on an average household size of 3.25 persons per household, the 2000 Census average for Fort Greely). The fort's current housing inventory totals 354 units. Housing demand related to construction of a natural gas pipeline would presumably be met with temporary facilities provided by construction contractors.

- **Socioeconomic Conditions in the Fairbanks North Star Borough**

According to ADOL projections, the Fairbanks North Star Borough is expected to grow at an annual rate of slightly less than 1 percent during the next 12 years. The ADOL "middle" case projection shows the borough growing at a rate of 0.95 percent annually through 2003, 0.84 percent annually through 2008, and 0.77 percent annually through 2013. These growth rates would push the borough's population to 88,012 by 2003, 91,773 by 2008, and 95,367 by 2013 (ADOL, 2002).

The local economy will continue to be based on the military, the University of Alaska, tourism, and oil industry activity. Other basic economic activity, including mining, transportation, regional health care, state government, and federal government, will continue to play a role in the local economy. Construction of a gas pipeline could increase the relative importance of oil and gas activity in the area. There are no foreseeable events that are likely to fundamentally change the socioeconomic composition or outlook for the area.

4.11.2 Options Common to All Alternatives

Among the options common to all alternatives, only airstrip operation and disposition have the potential to affect socioeconomic conditions in the Delta area, although these potential affects are nonmeasurable. For example, if the airstrip were open to use by Pogo and other industrial users, or open to everyone, it could in some measure facilitate additional industrial and commercial activity in the area. This industrial and commercial activity could create additional economic growth, population growth, and demand for public services. Prediction of the nature or magnitude of this activity, if it were to occur at all, is too speculative, however. Of course, if the airstrip were open to Pogo only, this potential for additional industrial or commercial activity in the area would not exist.

The same is true for the airstrip disposition options. If left open to other industrial users or open to everyone, it would be possible that additional industrial and commercial development would be facilitated. This development could create new economic activity, population growth and demand for public services. Removal and reclamation of the airstrip would eliminate this potential.

4.11.3 Options Not Related to Surface Access

Power Supply

Power supply options could result in slightly different socioeconomic consequences. The grid power option (Alternatives 2 and 3) would have greater potential for supporting additional industrial and commercial activity than the on-site generation option (Alternative 4). With grid power in place, other mine developers could enjoy a substantial construction and operation cost savings, compared to constructing a new power line or providing on-site generating capacity. This savings alone would be unlikely to be the determining factor in mine (or other industrial) development, but it could certainly be an important factor. To the extent that grid power availability does facilitate additional industrial/commercial development, this option could create new economic activity, population growth, and demand for public services.

The probability of the power line remaining after Pogo Mine closure is small for the following reasons: no other major ore deposit in the project area that could benefit from a power line is currently identified; bringing a major project into production normally takes at least 10 years; the life of the Pogo Mine is estimated at only 11 years; and the power line would be removed under all the alternatives.

4.11.4 Options Related to Surface Access

The magnitude of Pogo mine socioeconomic effects on the Delta area would depend on mine access. With an all-season road, a larger proportion of the mine's employees could reside in the local area because work and off-work periods would be shorter, and employees would be bused to and from the mine site. With winter-only access, employees would work for longer periods, have longer off-work periods, and be flown to and from the site, conditions that would allow workers to live more distant from the Delta area.

- **Delta Area Employment**

  Because mine workers would be housed on site and transportation would be provided to and from Fairbanks, a majority of the workers would be drawn from the Fairbanks labor market under any access option. It is not possible to predict with any degree of certainty the number of mine workers that would actually choose to reside in the Delta area. For purposes of this analysis, however, it is assumed that approximately 25 to 35 percent of the mine's workers would reside in the Delta area with an all-season road. That range suggests that between 100 and 135 of the mine's 385 employees would live in the Delta area once the mine were in full production.

  The number of indirect and induced (collectively termed indirect) jobs created in the Delta area would be less than might be the case with a higher level of development in the local service and support sectors. Mine development near an urban area, such as the Fort Knox mine near Fairbanks, can have a multiplier effect of nearly 2.0. The multiplier effect means that for every job at the mine, another job would be created in the local support sector. In the case of Pogo, the multiplier effect in the Delta area would be much smaller. Almost no mine operation spending could be expected; therefore, most of the multiplier effect would stem from the goods and services required by the mine employees who resided locally. A great deal of local econometric modeling (which is beyond the scope of this analysis) would be required to definitively determine the local multiplier. It is sufficient for this analysis to assume that the local multiplier would probably be no more than about 1.3; i.e., for every job at the mine, 0.3 job would be created in the local support sector. Based on this multiplier, 100 to 135 mine employees residing in the Delta area could create another 30 to 40 jobs in the local economy. This additional local employment would bring the total local employment impact to between 130 and 175 jobs for local residents under the all-season road option. This additional local employment would have a very substantial positive effect on the local economy.

It is important to recognize that this employment estimate is contingent on several factors. Most important among these factors is availability of local labor and local housing. If there were little interest among local residents in joining the mine's workforce, there could be a much lower level of local employment. Further, the number of available housing units could determine how many nonlocal mine workers choose to relocate to the Delta area. The estimate made in this analysis that 25 percent to 35 percent of the mine's labor force would reside locally is based on the assumption that there would be both a high level of local labor interest and sufficient housing to induce some nonlocal workers to relocate to the Delta area.

With the winter-only access option, fewer mine workers would reside locally. The number of local resident workers would depend, in part, on provisions made by the mine operator to provide transportation between the mine site and the Delta area. By providing transportation between the Delta area and the mine site, the community could realize greater local economic benefit from mine operations than would otherwise be the case. Nevertheless, the level of local participation in the mine workforce would be lower in the winter-only access option. Again, understanding the high degree of uncertainty associated with these estimates, it is assumed that 10 to 20 percent of the mine's labor force, or between 40 and 80 workers, would reside in the Delta area with the winter-only access option. With this option, there would likely also be a lower multiplier effect. Applying a slightly lower multiplier than was used in the all-season option analysis (1.2 versus 1.3), indirect employment could range between 10 and 15 additional jobs in the local support sector. This level of indirect employment would bring total mine-related employment with the winter-only access option to between 50 and 95 jobs. While this employment effect is lower than the all-season road option, it would still represent a substantial positive impact on the local economy.

Access options concerning use of an all-season and/or winter-only access during Pogo project operation also have socioeconomic implications. First, both options would increase access for mineral exploration and development in the area. This improved access could facilitate new or expanded mine development and operations that would create additional economic activity, population growth, and demand for public services. It is too speculative, however, to attempt to quantify this potential increase in economic activity.

The all-season road option also could result in increased timber harvests from state lands. This increased timber harvest, of course, assumes that the all-season road would be open to other industrial/commercial users. Similarly, if an all-season road were open to all users, an increase in recreational traffic to and through the Delta area could occur. In both of these instances, however, the local socioeconomic effects likely would be low.

✦ Delta Area Population

With an estimate of total local mine-related employment (including direct and indirect) of between 130 and 175 jobs with the all-season road option, it is possible to roughly predict the local population impact (Table 4.11-1). Including mine workers, their dependents, and indirect population effects, a total population impact of between 260 and 350 residents could result. This estimate is based on a participation rate of 0.5. The participation rate indicates the relationship between the number of jobs in an economy and the total population of the area. A participation rate of 0.5 means that for every job, there are two residents in the local area. The historical participation rate in the Southeast Fairbanks Census Area, which includes the Delta area, is approximately 0.42. In comparison, the Fairbanks participation rate is about 0.58 and the Alaska average is 0.61. The participation rate of the Southeast Fairbanks Census Area is typical of rural areas, where there are a large number people unemployed or not in the labor force, but probably does not give an accurate picture of the population effects of the Pogo mine. An urban participation rate of approximately 0.6 is too high, however, given the limited employment opportunities available to spouses and dependents of mine workers. Therefore, a mid-range rate of 0.5 is used in this analysis.

A population effect of between 260 and 350 residents with the all-season road option would be equal to approximately 15 percent to 20 percent of the Delta area's 2002 population of approximately 1,716 residents. It is important to recognize that this analysis does not suggest that the Pogo mine would draw between 260 and 350 new residents to the Delta area. The number of new residents probably would be smaller. Actual local population effects would be contingent on many factors, particularly availability of local housing, the availability of local skilled labor at the time operations commence, labor market conditions in Fairbanks, and a variety of other factors. In any case, given the economic hardship now being experienced in the Delta area due to base closure, this potential population effect would be substantial and positive.

Table 4.11-1 Employment and Population Effects of the Pogo Mine All-Season and Winter-Only Access Options

	All-Season Road	Winter-Only Access
Direct employment	100 - 135	40 - 80
Indirect employment	30 - 40	10 - 15
Total employment	130 - 175	50 - 95
Mine-related population	260 - 350	100 - 190
Delta area total[1]	1,716	1,716
Percent of Delta area total	15% - 20%	6% - 11%

[1] Based on 2002 ADOL data, including Delta Junction, Big Delta, Fort Greely, and Healy Lake.

Including their dependents and the indirect and induced population, total Delta area population effects would be between 100 and 190 residents under the winter-only access option. This figure is equal to between six percent and 11 percent of the 2002 population of approximately 1,716 residents. This estimate also is based on a participation rate of 0.5, applied to the approximately 50 to 95 new local jobs created as a result of the mine. Again, actual population effects would depend on several factors, including availability of local skilled labor, housing availability, and perhaps most importantly, provisions made by the mining company to transport employees between the Delta area and the mine. As with the all-season road option, these population effects would have a substantial, positive impact on the local economy.

✦ **Delta Area Income**

According to ADOL (2000a), the statewide average annual earnings for workers in the hardrock mining industry in 1999 was $66,048. Applying this average to the 385 jobs created at the Pogo mine suggests that annual payroll from the mine would total approximately $25.4 million. This estimate does not include labor overhead such as health insurance benefits, the cost of other benefits, or payroll taxes paid by the employer. An average annual salary of approximately $66,000 would be approximately 130 percent above the nonagricultural wage and salary employment average for the Southeast Fairbanks Census Area.

The positive effects of the all-season road option on personal income would be substantial. With the all-season road option, the assumption is that between 100 and 135 of the mine jobs would be held by people living in the Delta area (including current residents who gain employment at the mine and nonlocal mine employees who relocate to the Delta area). Local mine payroll, therefore, would be between $6.6 million and $8.6 million annually (Table 4.11-2). Indirect and induced payroll also would be created in the Delta area. Based on a weighted-average salary for the retail, service, and local government sectors combined, the average annual support sector salary for the Southeast Fairbanks Census Area is $19,350. Based on that average, the 30 to 40 jobs created in the local support sector would account for between $580,000 and $770,000 in annual payroll. This amount would bring total mine-related payroll in the Delta area to between $7.2 million and $9.4 million annually. This amount would represent 15 percent and 20 percent of the total non-agricultural wage and salary payroll in the Southeast Fairbanks Census Area.

Table 4.11-2 Income Effects of the Pogo Mine All-Season and Winter-Only Access Options (millions)

	All-Season Road	Winter-Only access
Direct mine payroll	$6.6 – $8.6	$2.6 – $5.3
Indirect	$0.6 – $0.8	$0.2 – $0.3
Total	$7.2 – 9.4	$2.8 – $5.6
Census area total[1]	$47.1	$47.1
Percent of census area total	15% to 20%	6% to 12%

[1] Southeast Fairbanks Census Area total for 1999. Source: ADOL

The winter-only access option also would have substantial positive impacts on local personal income, although less so than for the all-season road option. With the winter-only access option, the assumption is that between 40 and 80 of the 385 mine jobs would be held by people living in the Delta area. This employment of Delta residents would generate direct local payroll of between $2.6 million and $5.3 million. The 10 to 15 support jobs created as a result of Pogo Mine operations would generate another $200,000 to $400,000 in annual payroll. This additional payroll would bring total mine-related payroll, in the winter-only access option, to between $2.8 million and $5.7 million annually. The total payroll would represent between 6 percent and 12 percent of total nonagricultural wage and salary payroll in the Southeast Fairbanks Census Area.

✦ **Delta Area Public Services**

The effect of mine development and operations on public services in the Delta area is difficult to predict. As indicated above, between 10 percent and 35 percent of the mine’s workforce could eventually reside in the Delta area, depending on the access option. Some portion of this workforce, however, would be composed of people who already live in the area. They would place no additional demands on local public services. A relatively high unemployment (and what is probably a high level of underemployment), coupled with mining-related training opportunities, suggests it is reasonable to assume that current residents would comprise a large portion – perhaps half or more – of the mine’s local workforce.

If it is assumed that nonlocal workers relocating to the Delta area would account for half of the mine’s local work force; the actual population gain due to the mine would be between 130 and 175 new residents with the all-season road option. With the winter-only access option, it is assumed that fewer nonlocal mine workers would relocate to the Delta area; therefore, less additional demand would be placed on local public services.

The effect of the Pogo Mine project on the local school system likely would be low. Typically, school-age children comprise approximately 20 percent of a community’s population. More precisely, statewide, school-age children account for 22 percent of Alaska’s total population according data published by ADOL. Based on this percentage, the 130 to 175 mine-related residents new to the Delta area would include between 30 and 40 school-age children. This addition of school-age children would represent an increase in enrollment of between 5 percent and 6 percent over the FY 2001 DGSD enrollment total of 630 students (not including telecommuting students enrolled in the district’s Charter Cyber School). School funding is based in part on enrollment; therefore, these mine-related children would bring with them additional state foundation formula funding.

A mine-related increase in Delta area population would result in a slight increase in demand for other public services (e.g., community center, library, and emergency response services). Offsetting the costs associated with this increase in demand for public services, the mine-related population also would bring with it some increase in revenue from user fees and population-based revenue sources such as state revenue sharing and municipal assistance. The City of Delta Junction does not levy property or sales taxes.

In summary, the mine-related population would not have an adverse effect on local ability to provide public services or the cost of those services. Also, it is important to note that if the community is concerned about potential adverse impacts of the mine’s population on local public services, it would be possible to completely eliminate such impacts by asking the mining company to not provide transportation to the mine from the Delta area. Even in the case of the all-season road, the mine operator could take steps to discourage nonlocal employees from relocating to the Delta area. This approach, of course, would eliminate any potential economic benefit the area might enjoy if nonlocal employees were encouraged to relocate to the area.

✦ **Delta Area Housing**

In large measure, the availability of local housing would determine the number of nonlocal mine workers who choose to relocate to the Delta area. If adequate housing were not available, either due to location, quality, or price, workers would choose to live somewhere else, probably in the Fairbanks area. Previously it was assumed the mine would bring between 130 and 175 new residents to the Delta area if the all-season road option were constructed, and between 50 and 95 new residents for the winter-only access option. These estimates assumed these people would find suitable housing in the area.

To predict the number of housing units that would be required to meet housing demand, estimates of average household size are needed. Statewide, the average household includes 2.74 members, according to 2000 Census data. The typical household in the Southeast Fairbanks Census Area is slightly larger, with 2.8 persons per household. If it is assumed that the average household size for the mine-related population would be the same as the average for the census area, the mine-related demand for housing would be between 45 and 60 units for the all-season road option, and between 20 and 35 units for the winter-only access option. These unit figures are for the housing required to meet the needs of the nonlocal mine workers who choose to relocate to the Delta area.

According to the 2000 Census, the total housing stock in the Delta Junction, Big Delta, and Fort Greely areas was 1,008 units in 2000. Approximately 600 of these housing units were occupied in 2000. Among the unoccupied units, 80 were for seasonal, recreational, or occasional use. Of the roughly 330 remaining vacant housing units, 228 were at Fort Greely. The 100 vacant housing units in the Delta area outside of Fort Greely probably included a broad range of housing in terms of quality and price.

While the 2000 Census indicates a large amount of vacant housing, the NMDS construction project has apparently temporarily consumed available housing in the area. Although vacant housing remains in the Delta area, this housing is primarily military housing and therefore unavailable to the civilian population. (Some of the construction workforce is housed on base.) The housing demand spike created by the NMDS construction-related population is temporary and should begin easing in 2004. If Pogo Mine construction were to begin during NMDS construction, essentially no local housing would be available to the mine's nonlocal construction labor force. However, no local housing impact would be expected, because the construction effort would be camp supported.

Based on the most recent available published data (ADOL, 2002), NMDS operations personnel in Delta will total 150, including 50 military and 100 civilians. This number is subject to change, however, and could increase. The impact of this population on the Delta housing market will depend on the availability of base housing to civilians, something that has not yet been determined. If the civilian labor force must live off base, Pogo operations could be occurring when there is little available housing in the Delta area. It is important to stress, however, that a housing shortage would not necessarily have negative socioeconomic consequences. It could be argued that if demand exceeds supply, housing costs could go up, which is good for property owners, and perhaps bad for renters. In any case, as long as the mine operator provides transportation from Fairbanks, the housing supply from which miners are choosing includes the entire Fairbanks area. Mine workers would not be required to live in the Delta area.

In summary, the effects of Pogo on the housing market could be substantial, though generally positive. Local homeowners could expect to see the value of their homes rise. Some new construction could be expected, creating additional economic opportunity for local builders. It is possible that renters could see a rise in rental rates, as the demand for rental housing increases. These conclusions apply to both the all-season road and winter-only access options, with the effects somewhat more pronounced for the former for which greater demand for local housing is expected.

✦ Socioeconomic Impacts in the Fairbanks North Star Borough

The socioeconomic effects of the Pogo mine on the FNSB also depend on the access option. In either case (all-season road or winter-only access), however, the socioeconomic effects would be positive, though low in relation to the overall economy. For example, the winter-only access option could result in as many as 355 to 515 new jobs in the FNSB economy. That job increase only would account for between 1.1 percent and 1.6 percent of the nonagricultural employment in the borough. Impacts on population, housing, school enrollment, and other public services would be similarly proportioned.

The Pogo Mine would directly account for between $17 million and $19 million in payroll in the Fairbanks economy under the all-season road option, and between $20 million and $23 million in the winter-only access option (Table 4-11.3). These income figures represent between 1.5 and 2.0 percent of total Fairbanks wage and salary income. The mine also would create jobs and income in the local support sector. Based on a multiplier of 1.5 (one direct job creates another half job in the support sector), the mine indirectly would create between 125 and 170 jobs in the Fairbanks support sector. These jobs would account for between $3 million and $4 million in payroll, based on an assumed average wage in the annual support sector of $25,000. This additional payroll would bring the total Pogo-related income effects in Fairbanks to between $20 million and $27 million annually, or between 1.7 and 2.4 percent of the Fairbanks total.

Table 4.11-3 Socioeconomic Effects on the Fairbanks North Star Borough (FNSB) of the Pogo Mine All-Season Road and Winter-Only Access Options

Mine-Related	FNSB	All-Season Road	Percent of FNSB Total	Perennial Winter Trail	Percent of FNSB Total
Direct employment	–	250-285	0.7 – 0.9	305 – 345	0.9% – 1.1%
Indirect employment	–	125-140	0.4	150 – 170	0.50%
Total mine-related employment	32,538	325-425	1.0 – 1.3	355 – 515	1.1% – 1.6%
Direct payroll ($ million)		$17 -$19	1.5 – 1.7	$20 – $23	1.7% - 2.0%
Indirect payroll ($ million)		$3.1 - $3.5	0.2 – 0.3	$3.8 – $4.2	0.3% - 0.4%
Total mine-related payroll ($ million)		$20.1 - $22.5	1.7 – 2.0	$23.8 – $27.2	2.0% - 2.4%
Population	82,840	650-850	0.8 – 1.0	710 – 1,030	0.9% – 1.2%
Housing	33,291	240-315	0.7 – 0.9	260 – 380	0.8% – 1.1%
School enrolment	16,000	145-185	0.9 – 1.2	155 – 225	1.0% – 1.4%

4.11.5 Cumulative Impacts

✦ Delta Area Employment

With both the all-season road and winter-only access options, cumulative employment depends on the timing of development and operations. If mine construction begins in 2003, the project could be coming on line during construction of the NMDS and/or the natural gas pipeline. By the end of the decade (or once these projects are complete and operational and the mine is in full production), a total of between approximately 310 and 355 new permanent jobs would be added to the local economy in an all-season road option. This additional employment includes approximately 100 to 135 Pogo jobs and approximately 150 NMDS jobs. This estimate also includes approximately 30 to 40 indirect Pogo jobs and approximately 30 indirect NMDS jobs.

With the winter-only access option, a total of between approximately 230 and 275 new permanent jobs would be added to the local economy. This additional employment includes approximately 40 to 80 direct Pogo jobs and 150 direct NMDS jobs. This estimate also includes approximately 10 to 15 indirect Pogo jobs and 30 indirect NMDS jobs.

Cumulative impacts under both the all-season and winter-only access options, therefore, would have major positive economic effects in the Delta area. Under the all-season road option, the employment gain would represent an increase of between approximately 56 percent and 80 percent over the current nonagricultural employment total of approximately 720 jobs. In the winter-only access option, the increase would be between approximately 43 percent and 50 percent.

✦ Delta Area Population

Mine construction would not be expected to measurably affect the Delta area population. Mine construction jobs would be temporary, camp-supported, and filled primarily by nonlocal workers.

Cumulative population impacts from mine operations depend on the timing of development and operations. The project could be coming on line during construction of the NMDS and/or the natural gas pipeline. By the end of the decade (or once these projects were complete and operational and the mine were in full production), the total population effect of these two developments would total between approximately 610 and 700 persons. The net increase in Delta area population would be less than the total population effect because some of the predicted population effect includes people already living in the area. The total Delta area population would rise to approximately 2,300 to 2,400 residents (Table 4.11-4). Therefore, the Pogo Mine would have a substantial effect on the local population, directly or indirectly accounting for between approximately 11 percent and 15 percent of this population.

The total population effect of Pogo and NMDS under the winter-only access option would be between approximately 445 and 540 persons. The Delta area population would increase to between approximately 2,100 and 2,200 residents within 10 years. The Pogo Mine would directly or indirectly account for approximately 5 to 9 percent of this population. Although less important than the all-season road option, the effects of Pogo under this option would still be positive for the local economy.

Table 4.11-4 Cumulative Employment and Population Effects of Pogo Mine and NMDS

	Pogo	NMDS	Cumulative
All-Season Road			
Direct employment	100 - 135	150	250 - 285
Indirect employment	30 - 40	30	60 - 70
Total employment	130 - 175	180	310 - 355
Population	260 - 350	350	610 – 700
Delta area population			2,300 – 2,400
Winter-Only Access			
Direct employment	40 - 80	150	190 - 230
Indirect employment	8 – 15	30	38 - 45
Total employment	48 - 95	180	230 - 275
Population	95 - 190	350	445 – 540
Delta area population			2,100 – 2,200

✦ Delta Area Income

Data is not available on the earnings that would be earned by the NMDS workforce; therefore, it is not possible to predict cumulative payroll effects. It is possible, however, to provide an estimate of the total personal income effects, based on per capita income data. Per capita income in the Southeast Fairbanks Census Area was approximately $22,400 in 2000 (U.S. Department of Commerce, 2001). Under the all-season road option, cumulative effects would push the Delta area population to between approximately 2,300 and 2,400 residents. Applying the 2000 per capita income estimate to this population suggests that total annual personal income in the Delta area would rise to between approximately $52 million and $54 million. This estimate may understate actual personal income because the mine and NMDS-related populations likely would have higher household income levels due to the higher paying mine and military jobs. Based on average per capita income for the 2000 census area, personal income in the Delta area in 2000 is estimated at approximately $40 million. Cumulative effects of the all-season road option would include a very substantial increase in per capita income of between 30 percent and 35 percent.

Under the winter-only access option, population effects would be lower; therefore, personal income effects would be lower, though still substantial. Under the winter-only access option, Delta area population would climb to between approximately 2,100 and 2,200 and personal income would rise to between approximately $47 million and $49 million. This higher personal income would represent an increase of between 18 percent and 23 percent over the estimated 2000 total.

✦ Delta Area Public Services

Under the all-season road option, the total Delta area population would rise to approximately 2,300 to 2,400 residents during the next 10 years, assuming that both the Pogo Mine and NMDS were developed. Under the winter-only access option, the

Delta area population would rise to between approximately 2,100 and 2,200. These population increases would place additional demands on public services.

The cumulative effect on local schools could be substantial, with the number of school-age children in the area potentially increasing over current levels by between 35 percent and 40 percent in the all-season road option. This increase in school-age children could push the number of school age children in the area to between 700 and 750. Under the winter-only access option, the number of school-age children in the Delta area would increase by between 23 percent and 30 percent, or up to a total of between 675 and 700. This increase could have potentially substantial effects on school district operations. School enrollment, however, has declined sharply in recent years, resulting in the closure of schools in Fort Greely and Healy Lake. Facilities are in place, therefore, to accommodate at least some of the potential long-term increase in enrollment.

The demand for other public services also would increase, although not necessarily at a rate proportional to population increase. Emergency response services, for example, serve residents and travelers. In any case, in the absence of detailed impact assessment information on the NMDS, it is not possible to predict, in detail, cumulative public services effects.

✦ **Delta Area Housing**

Total cumulative housing demand for the Delta area under the all-season road option would be expected to total between approximately 820 and 860 units. Under the winter-only access option, total cumulative housing demand would be expected to total between approximately 750 and 785 units.

The total housing stock in the Delta area in 2000 was 1,008 units, according to the census. A substantial number of these units are seasonal, recreational, or occasional use housing, or otherwise generally not a part of the available housing inventory. Construction of the NMDS has apparently consumed most of the available housing; therefore, vacancy rates are very low. NMDS construction in the Delta area is expected to be complete in 2004, when the construction labor (which is expect to peak at 500 jobs) is replaced with an operational labor force of 150 (including 50 uniformed and 100 civilian personnel). At that time, local housing demand would decline, with availability of base housing for the civilian population a key factor.

Housing demand related to operation of the Pogo Mine and NMDS could push local housing demand to a level in excess of available housing. A number of factors, however, would determine the actual impact on the local housing market. First, whether existing on-fort vacant housing would be made available. Second, given the local economic stimulus that the NMDS and Pogo projects would bring to the Delta area (particularly the NMDS), it is likely that the private sector would respond by developing new housing. Third, if adequate housing were not available at the time these two projects go into operation, the federal government likely would construct new housing for the NMDS-related population. Fourth, if adequate housing were not available for the mine-related population, nonresident workers would simply choose to live elsewhere, probably Fairbanks, a community with a much larger housing inventory.

A more detailed assessment of cumulative housing impacts is not possible in the absence of detailed data on the NMDS. In any case, the cumulative effects on the local housing market would be generally positive, resulting in increased valuations and additional housing construction. At the same time, local rental rates could rise.

✦ **Borough Formation**

Development of the Pogo Mine could, but is unlikely to, indirectly hasten the formation of a borough government in the Delta area. Increased population generally results in increased demand for public services of the kind sometimes provided by borough governments. Pogo Mine development alone would not increase the area population to levels above that of pre-military base closure. However, NMDS-related development, plus Pogo-related development, could push the area's population to higher levels.

It is beyond the scope of this study to assess the feasibility of borough formation in the Delta area. However, the key issue regarding borough formation is the ability of the Delta area to generate revenues to support borough government operations. Borough formation becomes feasible when an area reaches a certain threshold in terms of taxable residential, commercial, and industrial development.

The Delta area could become part of a borough in one of two ways: either through internal initiative, based on a perceived need for more or better public services, or the remote possibility that a neighboring borough might seek to annex the Delta area, if the area includes attractive revenue sources.

Neither case appears likely. The cumulative effects scenario includes development of both the Pogo Mine and the NMDS. In this scenario, the largest source of local economic activity, the military, is not subject to property taxes (and federal purchases are not subject to sales taxes). Federal payments in lieu of taxes could provide money to a borough-run school district, but a Delta borough with powers beyond school operations is still unlikely to generate the needed tax revenues.

Concerning annexation, a mine's potentially high property valuations could represent an attractive source of revenue for nearby boroughs. However, it is unlikely that any of the boroughs adjacent to the Delta area (Fairbanks North Star, Denali, and Matanuska-Susitna boroughs) would find that the potential revenue from taxation of the Pogo Mine (and other taxable property) would cover the costs of expending services to the very large Southeast Fairbanks Census Area.

4.12 Land Use

The severity of land use impacts was considered in the context of whether land use changes would occur that would be in conflict with existing state and local government land use plans. Based on the existing land use inventory discussed in Section 3.17 (Land Use), and applicable land management plans, there would be no major conflicts with the land use plans or land management policies of the TBAP, the TVSF Management Plan, or the FNSB Comprehensive Plan from development of any of the alternatives. Therefore, there would be no major impacts on land use.

Certain components of project alternatives, however, could cause substantial *changes* to existing residential and recreational land uses in the project area, although these changes still would be consistent with the TBAP, TVSF Management Plan, or FNSB Comprehensive Plan. These changes in existing land use would be considered as impacts to some. Conversely, land use changes also could be of substantial benefit to new recreational, commercial, and industrial users of the area.

4.12.1 No Action Alternative

Under the No Action Alternative, land use changes would be consistent with existing state land use plans. Changes would occur commensurate with current economic development trends in the Delta area and construction of the NMDS and a natural gas pipeline. New residential, commercial, and industrial activities (housing, lodges, stores, and quarries) would occur in the existing developed Delta area at a level consistent with ongoing needs or other actions in the area.

Construction of the NMDS would cause a temporary, 2- or 3-year increase of commercial and industrial land sales in the Delta area. There could be some increase in residential land sales. Natural gas pipeline-associated activities would last only during the approximate 2-year construction phase of the project, with housing needs presumably met with temporary facilities provided by construction contractors. Private land sales for residential, business, and industrial purposes would continue to meet local needs.

The current DOF 5-year schedule for timber sales (2003–2007) in the Delta area includes four sales on the north side of the lower Shaw Creek drainage and the Tenderfoot area and four sales in the Quartz Lake and Indian Creek area (ADNR, 2002). These eight sales would affect approximately 1,313 acres, not including new roads. Implementation of this harvesting plan would affect existing land uses although it would be consistent with the TVSF Management Plan. Two state timber sales totaling approximately 264 acres are planned in the Keystone Bluff area of lower Shaw Creek Valley (ADNR, 2002).

The DOF planned road for the Shaw Creek timber harvest would follow closely the Applicant's proposed alignment for the Shaw Creek Hillside all-season road in the lower and middle portions of the drainage. This road likely would be constructed incrementally over the next several years, depending on sale of the proposed harvest units and additional capital funding. It would be open to use by the public, as well as by logging trucks. These timber sales would cause land use changes that would affect existing residents of Shaw Creek Road, as well as trappers, mushers, a commercial recreational tour company, and recreationists currently accessing the backcountry of the Shaw Creek drainage.

The DOF eventually would construct its planned road around Quartz Lake to access timber in the vicinity of Quartz Lake and Indian Creek near the route for the South Ridge all-season road route. Like the proposed Shaw Creek Hillside forestry road, it likely would be constructed incrementally and would be dependent on additional capital funding or timber sale activity. It would not be constructed to the standards of the Applicant's proposed road. Both planned timber roads, assuming they were open for public use, could cause a substantial change in current land use in the vicinity of the roads.

Historically, the number of daily truck round trips during timber harvest activities associated with a particular timber sale in the Delta area have varied between 1 and 15. Normally, an operator delivers two loads per day, and the customary spread is from one to four loads per day. Timber sale contracts normally have a duration of 3 to 5 years, but could be as long as 10 years (Joslin, 2002). Depending on the sale, the estimated total number of truck trips for timber sales in the project area on the DOF 5-year schedule varies between 142 and 950 (over a 3- to 10-year period), with an estimated approximately two to three daily round trips (Table 3.17-2).

Overall, because land use changes under the No Action Alternative would be consistent with existing state land use plans, land use impacts would be negligible.

4.12.2 Options Common to All Alternatives

Air Access

Airstrip Use and Disposition The use and disposition of the airstrip could have a major impact on other commercial and industrial land uses in the project area. Closing the airstrip to everyone but the Pogo project could have a major negative effect on potential new commercial and industrial activities, such as mining.

Allowing other commercial and industrial users to access the airstrip would provide commercial air operators with new service options supporting new commercial and industrial activities in the project area, as well as fly-in recreationists. Removing and reclaiming the airstrip at the conclusion of the Pogo project could have a major impact on commercial air operators, and to potential new mine development in the area.

4.12.3 Options Not Related to Surface Access

Alternative 2

Power Supply

- Power Line A power line would make power available in the upper Shaw Creek and Goodpaster River valleys and thus could be beneficial to potential new commercial and industrial land uses in those areas. It would not be of benefit to scattered residential users in these areas because of the high cost of a substation required for such users.

  A cleared power line ROW would be a moderate benefit to new recreational users because backcountry areas currently with difficult access for recreationists would be more accessible to both motorized and nonmotorized users.

Alternative 3

Power Supply

- Power line Same as for Alternative 2, except the power line would not access Shaw Creek Valley.

Alternative 4

Power Supply

- On-site generation This option could have an impact on other potential commercial and industrial users. Additional mineral development in the area could be slower because lack of a power line to the Pogo Mine site would require on-site generation at new sites or separate construction of a power line.

4.12.4 Options Related to Surface Access

The type and location of surface access, and the power line route, could be important for existing and new residential, commercial, and industrial land uses in the Pogo area, although there would not be conflicts with existing land use plans.

Alternative 2

Surface Access

Use The Shaw Creek Hillside all-season road would not cause substantial changes to existing land use in Shaw Creek and Goodpaster River valleys if it were open only for use by the Pogo project or industrial / commercial users. Existing land uses in these valleys, however, could be substantially changed if the road were open to public use because it would provide access to presently remote areas. In particular, some existing land uses, such as the Goodpaster recreational cabins located downstream from a new Goodpaster River access point near the mine site, would be affected. Recreationists, fishers, and other new users in the upper drainage could be expected to travel down the Goodpaster River and through the lower reaches, affecting those cabin owners.

Conversely, all-season road access could benefit new commercial/industrial land users. Increased access to more remote areas of the Shaw Creek and Goodpaster drainages could substantially benefit potential users considering new developments in these areas.

- Richardson Highway egress Regardless of whether the Shaw Creek Hillside all-season road were open to public use or whether Shaw Creek/Rosa or the Tenderfoot sub-option were built, the Shaw Creek area in general could experience some increase in residential use during project operations by workers building homes to reduce commuting time to the Applicant's bus terminal. This increased residential use could depend on how work shifts were structured, and would be moderated by the fact that there is limited residential property available in this area. Commercial and industrial land sales and development as a result of the Pogo Mine could cause changes to existing land uses in the Shaw Creek, Tenderfoot, and nearby Richardson Highway areas because the Delta area economy would experience development and growth as a result of the Pogo Mine.

- Security gate at Gilles Creek Limiting public access to the lower two-thirds of Shaw Creek Valley would substantially reduce likely changes to existing land uses beyond Gilles Creek that would occur if the public were able to use the road to reach the Goodpaster River.

Disposition Removing and reclaiming the Shaw Creek Hillside all-season road after the Pogo Mine project were completed would be a substantial impact to new residential, commercial, and industrial land uses that occurred because of the initial construction of the road, but existing land uses along Shaw Creek Road would not be substantially affected.

Historically, however, few roads in Alaska have ever been removed and reclaimed after a period of use. They either become part of the maintained state road system, or are abandoned and revert to four-wheel drive or ATV trails that still allow access. A decision at this time by ADNR to remove all or a portion of an all-season road could be changed in the future through a public involvement process pursuant to the TBAP.

If the road were open to the public during project operation, removing and reclaiming the road would be a substantial impact to existing commercial, industrial, recreational users, and any businesses such as lodges, stores, or other service-related industries that developed to support new backcountry users.

DOF forestry road It should be noted that the planned road for the DOF Shaw Creek timber harvest would follow closely the Applicant's proposed Shaw Creek Hillside all-season road alignment in the lower and middle portions of the drainage. Thus, if the winter-only access option were selected and the DOF road were built, all the impacts discussed above likely would still occur because the DOF road would eventually connect with the southern end of the all-season portion of the winter-only access. If the proposed Shaw Creek Hillside all-season road were constructed, however, the DOF road would not be built because the former would provide necessary access to timber resources on state lands. Spur roads, however, would be constructed as needed to support timber sale activities.

Alternative 3

Surface Access

Use Impacts would be similar to those for Alternative 2, except that the impacts to existing residential and other users near the Richardson Highway would occur in the vicinity of the highway and Quartz Lake rather than in the Shaw Creek Road area.

Alternative 4

Surface Access

Use The option of Shaw Creek Flats winter-only access would not cause substantial changes to existing land use in Shaw Creek Valley if it were open only for use by the Pogo project or industrial / commercial users. Some existing land uses in Shaw Creek Valley, however, could be changed if the road were open to public use, even though only seasonally, because it would provide a limited increase in access to presently remote areas.

Winter-only access, because of its seasonal nature, would be a benefit to existing residential and recreational uses in the Shaw Creek and Goodpaster valleys, including the Goodpaster cabin owners, even if it were open to public use, because users would be able to access the upper reaches of the Shaw Creek and Goodpaster drainages only in winter, which they can largely do now. Similarly, trappers, commercial sled dog tour operators, and other backcountry users would consider winter-only access less of an impact on their operations than an all-season road.

For potential recreational users, however, winter-only access, even if open for pubic use, would not allow increased access to the more remote areas of the Shaw Creek and Goodpaster River drainages during the 9 months when winter-only access were not passable.

The Shaw Creek Flats winter-only access option, compared to the all-season road options, generally would not be as beneficial to potential commercial and industrial users. While the winter-only access option likely could be used by other resource developments, it would not be as favorable as an all-season road because of its seasonal nature. New mineral and timber activities, and associated commercial land uses, likely would be slower to develop than with the all-season road option.

If the winter-only access option were selected and the DOF constructed its forestry road along the Shaw Creek Hillside, the DOF forestry road likely would connect with the all-season road segment of the winter-only access option. Because the forestry road would be open for public use, its presence would obviate the whole purpose of the winter-only access option, which is to isolate the all-season road segment from year-round public access. Impacts then would be similar to those discussed above for the Applicant's Proposed Project (Alternative 2).

4.12.5 Cumulative Impacts

- All-season Road Reclaimed The absence of an all-season road would limit other resource development activities and human use, and would change some then-existing land uses by removing the access that had allowed Pogo project development. There would be no cumulative impacts on land use because all uses still would be consistent with the TBAP.

- All-season Road Maintained The surface access and power line corridors to the Pogo Mine would provide the necessary infrastructure for a hypothetical Sonora Creek mine, and likely also a hypothetical Slate Creek mine, thus increasing commercial/industrial uses of these corridors. Use of these corridors by other mining companies would have cumulative impacts on existing and new land uses.

  An extension of the life of the Pogo project because of discovery of additional deposits in the near vicinity of the Pogo ore body would have relatively few additional cumulative impacts because most of the existing infrastructure would still be used.

  Road and power extensions from the Pogo mill to a hypothetical Sonora Creek mine would provide the necessary infrastructure for this new mining operation. Pogo Mine access and power would contribute substantially to the feasibility of new commercial/industrial land uses in the area, cumulatively affecting land uses. Mining-related service industries, such as air and land transport for mining activities, would consider the Pogo and Sonora Creek mine infrastructure important for their businesses.

  If the Pogo access road and power line were extended up the Goodpaster Valley to a hypothetical Slate Creek mine, this activity also would cause substantial changes to existing land uses, but still would be consistent with the TBAP. Remote reaches of the upper Goodpaster would become more economically accessible to new commercial and industrial land uses, possibly opening up other adjacent mining areas in the future. Existing trappers, recreationists, and other users of the area likely would consider such infrastructure a substantial change to existing land uses, while new commercial and industrial land users would consider such infrastructure a substantial benefit.

4.13 Subsistence

Because Native subsistence was identified as a scoping issue, the focus of the subsistence discussion in this EIS is on Upper Tanana Athabaskan subsistence uses. This focus is not meant to suggest that non-Natives are not subsistence users. Where non-Natives reside in the target Native communities, they also likely conduct seasonal harvest activities in the project area and may consider these activities subsistence uses. The ADFG subsistence use information, on which much of this analysis is based, includes community practices and not solely those of Native residents. Non-Native subsistence uses by residents of non-Native communities are included elsewhere in the EIS under sport hunting and fishing, and these non-Native users may individually consider themselves subsistence users.

In this section, potential subsistence impacts are discussed in the context of three direct impact criteria: subsistence resource availability, access to resources, and competition for resources for the Upper Tanana River Valley as used by Tanana Athabaskans. Factors influencing these criteria include:

- Availability — Changes in resource abundance and/or resource damage, displacement, or contamination. These changes to wildlife are based on the fish and wildlife impacts discussed elsewhere in this chapter.
- Access — Transportation corridors that would increase access or physical, regulatory, and/or social barriers that could restrict access
- Competition — Pogo project personnel, new and/or outside (the region) users, or existing users who harvest subsistence resources more frequently because of new or improved access to traditional harvest areas

References to historical and current Upper Tanana Athabaskan subsistence uses are defined as follows:

- Recent — Within the last 10 years
- Lifetime — Beyond the last 10 years

References to duration of impacts are defined as follows:

- Short-term — 1 year or less
- Moderate-term — More than 1 and up to 2 years
- Long-term — More than 2 years

References to important and key subsistence resources and species mean resources as measured by harvest effort, harvest amounts, or cultural importance.

Unless otherwise indicated, subsistence resource uses and use areas are based on SRB&A (2002a). The environmental effects described in this section are based on a more detailed analysis in SRB&A (2002b).

4.13.1 No Action Alternative

Under the No Action Alternative, there would be no or low effects on the availability of subsistence resources. Except for the local areas that would be accessed by the DOF's planned timber harvest roads in the Shaw Creek Valley and the vicinity of Quartz Lake and Indian Creek, there also would be no or low effects on access to and competition for subsistence resources. In those local areas accessed by the DOF timber harvest roads, there would be moderate effects to access (new transportation corridor) and competition (road users) for important subsistence resources (moose, caribou, waterfowl, and upland birds). These effects on access and competition, however, would be spread out over time, because the roads likely would be constructed incrementally.

The planned DOF all-season road and associated Shaw Creek timber harvest would occur in current and lifetime subsistence use areas for Upper Tanana Athabaskans. Recent subsistence use occurs in the affected area for caribou, moose, and upland birds. Recent use areas for waterfowl are adjacent to the proposed road corridor. Lifetime subsistence use occurred in the affected area for moose and upland birds.

Planned timber harvests in the vicinity of Quartz Lake and Indian Creek that would be accessed by winter roads would have no or low effect on subsistence resources. The planned DOF all-season road and associated harvests in this area that would be accessed by a proposed all-season road around Quartz Lake, however, would have a moderate effect on access to and competition for current Upper Tanana Athabaskan subsistence resources of moose, waterfowl, upland birds, and berries.

The effects of both roads on subsistence access and competition would be long-term, but could be mitigated if access to the roads by recreational users and other members of the public were restricted.

4.13.2 Options Common to All Alternatives

A portion of the mine area itself overlaps recent and lifetime Upper Tanana Athabaskan subsistence use areas for caribou and moose harvest. It also overlaps the lifetime use areas for trapping and harvest of upland birds. Thus, there is potential for a direct effect.

The primary effect of mine area development on wildlife would be its displacement from the mine area. Development of mine area facilities would have a low effect on subsistence availability except in the immediate mine area. Access to subsistence resources at the mine site by subsistence users would be diminished because hunting would be prohibited in the immediate mine area for public safety purposes. This area, however, is small within the context of the overall subsistence use area for caribou, moose, and upland birds. Competition for subsistence resources surrounding the immediate mine area would not be affected because of the Applicant’s no hunting and fishing policy for employees. Thus, effects of these common options would be high only at the mine site facilities. The duration of this impact would be long-term.

Recent Upper Tanana Athabaskan caribou and moose subsistence use areas are substantially larger than the footprint of the mine site, and the lack of availability of the mine site for subsistence hunting would not affect the overall pattern of subsistence use because other areas are available for harvesting these species. And, there would not necessarily be any increased effort, cost, and/or risks if subsistence hunters were unable to hunt at the mine site because this location is not a readily accessible area from any community. It would be more of a noticeable reduction in opportunity to hunt in a traditional place that was used by one’s relatives and ancestors. In this regard, it could be construed as a loss of a part of one’s homeland for hunting, but not the primary or most used hunting area.

Fuel Storage Location

- Temporary Storage The proposed temporary (2 year) fuel storage to be located below the existing 1525 Portal on the valley floor and at the airstrip would not be within the recent subsistence use area for fish. Recent subsistence fishing areas, however, are located downstream of the site in the Goodpaster River. If contamination from these facilities were to affect downstream areas, and fish in them, it could affect subsistence fishing. Any fish damage, decline, displacement, or contamination would affect availability to subsistence fishers. Furthermore, concerns about contamination could lead to reduced fish consumption (SRB&A and Usher, 1997). The fear of contaminated resources could long outlast any actual direct impacts to the fish resources. Depending on the duration and severity of contamination of the river, it could have a moderate effect on subsistence fishing uses.

  Fish is an important subsistence resource; the Goodpaster River is in the recent subsistence fish use area and the impact, depending on severity, likely would be clearly detectable to traditional subsistence users. Individual subsistence users and groups of users likely would be affected. Although there are substantial other areas available for subsistence fishing, and the overall pattern of subsistence uses would not be seriously jeopardized, the Goodpaster River is a currently used and highly regarded river by descendents and related kin of Athabaskans who used this area traditionally. The probability of such contamination from these facilities during the 2-year development phase, however, is low.

Air Access

Airstrip Use and Disposition How the airstrip would be managed during the period of mine operation, and whether the airstrip would be reclaimed at conclusion of operations, would affect access to the vicinity of the mine and therefore subsistence. For all three subsistence impact criteria of availability, access, and competition, the most restrictive airstrip use and disposition options (airstrip open only to Pogo project use during mine operations, and removal and reclamation at the end of mine operations) would have low effects. Conversely, the least restrictive options (airstrip open to everyone during and after mine operations) would have moderate to high effects.

4.13.3 Options Not Related to Surface Access

Alternative 2

Except for the components discussed below, impacts for this alternative would be of the same nature and degree as discussed for options common to all alternatives in Section 4.13.2 above.

Power Supply

- Power line Clearing of a power line ROW would create an access corridor for recreational as well as subsistence users; thus, access would be increased. This increased access could increase competition between recreational and subsistence users, and potentially among subsistence users. Increased access would occur over the life of the Pogo project in winter (snowmachine access), but possibly all year in current and lifetime use areas for important subsistence species. Thus, this option could have a moderate impact on access to and competition for subsistence resources. Mitigation measures to restrict ATV use of the power line ROW could limit access to some extent. To whatever geographic extent the road were open for use by everyone, however, the power line ROW likely would provide little access advantage because it would so closely follow the road alignment. In these co-aligned areas, the impacts would be small.

Alternative 3

Impacts for this alternative would be of the same nature and degree as discussed for options common to all alternatives in Section 4.13.2 above.

Power Supply

- Power line Same as Alternative 2.

Water Discharge

- Direct discharge to Goodpaster To the extent this option were to cause low to moderate impacts on fish and aquatic habitat from process upsets and facility failures which could lead to bioaccumulation of metals, as discussed in Section 4.8.3 (Fish), it could lead to impacts on subsistence fisheries farther downstream in the Goodpaster River, as discussed in Section 4.13.2 above. Depending on the duration and severity of contamination, such impacts could have a moderate effect on subsistence fishing uses. Because the probable frequency of the combination of events that would cause such impacts is low, and the dilution factor high, this option would have a low subsistence impact.

Alternative 4

Power Supply

- On-site generation This option would require greater on-site fuel storage and movement of approximately 4.2 million gallons fuel annually by tankers over surface access. These requirements would substantially increase the risk of fuel spills at stream crossings and from transfers between tankers and storage tanks, raising the same concerns for impacts to fish, fish habitat, and subsistence fisheries farther downstream as discussed in Section 4.13.2 above. Depending on the duration and severity of contamination, such impacts could have a moderate effect on subsistence fishing uses.

Water Discharge

Development and Operations Phases

- Off-river treatment works Impacts from this option could be the same as for Alternative 3; however, this option would have a lower probability of affecting water quality than would a direct discharge to the Goodpaster because of its more controlled environment and its 24-hour holding capacity following an upset. Therefore, the potential for impacts to subsistence resources with this option would be the lowest of the discharge options.

4.13.4 Options Related to Surface Access

Options related to surface access have the greatest potential to affect subsistence uses. The three key options are route location, who would use the road during mine operations, and disposition of the road after completion of the Pogo project.

Alternative 2

Surface Access

Route

- The Shaw Creek Hillside all-season road would have a low effect on the availability of subsistence resources. Depending on who would use the road during mine operations and disposition of the road after completion of the Pogo project, this alternative would have the potential to substantially increase access to resources in the Shaw Creek and upper Goodpaster River drainages, as well as the surrounding areas. Such increased access would result in increased competition for subsistence resources between recreational and subsistence users, and among subsistence users. Although improved access to an area could be viewed as a positive benefit for subsistence users, the overwhelming view at the 2002 subsistence workshop (SRB&A, 2002a) was that increased access was negative and would facilitate additional people entering an area, drive game farther away, and increase competition for resources. Based on workshop input, people who already use the area are satisfied with the current level of accessibility and providing increased or easier access would only complicate their lives and make it harder for them to secure resources.
  - Richardson Highway egress The Shaw Creek/Rosa egress option has more overlap with current subsistence use areas (e.g., caribou, moose, waterfowl, and berries) than does the Tenderfoot egress. Because Shaw Creek Road already provides access to these subsistence resources, and the Tenderfoot option would not provide materially greater access to these resources, there would be little difference in effects between the two options.

Use and Disposition For access and competition criteria, the most restrictive road use and disposition options (road open only to Pogo project use during mine operations and removal and reclamation at the end of mine operations) would allow the least access into the Shaw Creek and upper Goodpaster River drainages and would have the fewest impacts on subsistence. Conversely, the least restrictive options (road open to everyone during and after mine operations) would allow the greatest access and would have the most effects.

Opening the all-season road even to just other industrial and commercial users would augment the potential for increased access and competition for resources, and complicate enforcement of policies designed to restrict competition with existing resource users.

Opening the road to everyone would serve to open an area currently difficult for the general public to access. In addition to accessing the Shaw Creek and Goodpaster River drainages, if hunters and recreationists were able to use the road to cross the Goodpaster River, it could ease some of the problems of reaching the high country north and northeast of Healy Lake. Restricting road use to the west side of the Goodpaster River, however, would reduce this possibility. To the extent that opening the road to the general public would result in increased use of this area, this option would have the greatest effect on existing subsistence uses by creating substantially increased access and competition in current use areas for key species for a long time period over a potentially large geographic area, resulting in subsistence users needing increased hunting effort, having greater costs, not going to traditional areas as often, and having reduced harvest. This impact would be major within the local and regional context for present-day subsistence hunters who are descendents and related kin of Athabaskans who used this area traditionally.

The Shaw Creek Hillside all-season road would be located in recent Upper Tanana Athabaskan subsistence use areas for the harvest of caribou, moose, waterfowl, and upland birds, and in the lifetime subsistence use areas for moose, upland birds, and trapping. Caribou, moose, waterfowl, and upland birds are important subsistence species. Thus, there would be a direct effect from this alternative on access to and competition for subsistence uses of these species for Upper Tanana Athabaskan subsistence users as well as other traditional subsistence users. The duration of these impacts would be long-term. These impacts would be similar to the No Action Alternative impacts from construction and operation of the planned DOF forestry road.

At the same time, the recent subsistence use areas for these species are substantially larger than the immediate area of the Shaw Creek Hillside road. For those individuals who go to the Shaw Creek Flats area for waterfowl or to the surrounding area for caribou and/or moose, however, this road, regardless of access management policy, would have an effect on their activities. Traditional users may avoid the area because of the new road and traffic, and this avoidance (or social barrier) likely would increase if the road were open to non-Pogo users. In this sense, the road has the potential to be regarded as a loss of a part of one's homeland for hunting, not necessarily the primary or most used hunting area, but a hunting area that was historically and is currently used.

If the road were successfully managed to limit use to only the Pogo project, and if the Applicant's no hunting and fishing policy were strictly enforced, impacts likely would not affect the overall pattern of subsistence use. This is because other areas would be available for harvesting these species, and the restrictive road use policies and road removal would diminish the potential for new users to penetrate east, northeast, and southeast from the Shaw Creek Hillside and the mine area. If these policies were enforced, and the road removed and reclaimed, there would be a moderate effect on historic users of the area.

Less restrictive road use and road disposition policies could result in a substantial increase of recreation users into the area and expansion east and southeast from the road, which has the potential for a major impact on traditional subsistence users (e.g., direct effects).

- Security gate at Gilles Creek This option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. Access to the mine vicinity and the potential for sport hunters and other recreationists to use the road to cross the Goodpaster River and ease some of the problems of reaching the high country north and northeast of Healy Lake would not exist.

Power Supply

- Power line The effects of the Shaw Creek Hillside power line route would be related primarily to increased access. Because this route would be very close to the Shaw Creek Hillside all-season road, the power line's increased access impacts would be of little or no additional consequence.

Alternative 3

Surface Access

Route

- The South Ridge all-season road would be located in recent Upper Tanana Athabaskan subsistence use areas for the harvest of caribou, moose, fish, and berries, and in lifetime subsistence use areas for moose and trapping. Thus, there would be a direct effect from this alternative on access to and competition for subsistence uses of these species. The duration of these impacts would be long-term. The South Ridge all-season road impacts generally would be the same as those for Alternative 2, recognizing that subsistence use patterns along this route are slightly different.

Use and Disposition Same as for Alternative 2.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter only access would have impacts similar to the Shaw Creek Hillside all-season road option, except for the initial winter access route. The Shaw Creek Flats route would cross wetlands and transect recent Upper Tanana Athabaskan subsistence use areas for caribou, moose, waterfowl, and upland birds.

  Shaw Creek Flats is a traditional and current harvest area for “stray” caribou and a well-used waterfowl hunting area. Any fuel or cyanide accidents on the flats resulting in resource damage, decline, displacement, or contamination would affect availability to subsistence users. As discussed previously in Section 4.13.3 (Alternative 2), contamination concerns could lead to reduced resource consumption and years of wondering if the resources from the area as well as “downstream” were safe to eat. The larger the accident, the greater the concerns, and the greater the effect on subsistence harvesting and consumption.

Use and Disposition Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, subsistence impacts from public use would begin to approach those described for Alternative 2.

4.13.5 Cumulative Impacts

- All-Season Road Reclaimed Absence of an all-season road would considerably reduce resource development and recreational access to subsistence use areas that are currently difficult to access; therefore, it would have substantially fewer cumulative impacts.

- All-Season Road Maintained The direct subsistence impacts from the possible extended life of the Pogo Mine, and a hypothetical mine development in the headwaters of Sonora Creek just east of the Pogo Mine, would be similar to those already discussed above for the Pogo project because of the mine’s closeness to the Pogo Mine infrastructure.

A Slate Creek mine near the headwaters of the Goodpaster River approximately 25 miles northeast of Pogo that would be accessed by an all-season road, however, would provide even greater access into a currently inaccessible area, especially if open to use by the public. Such a road would extend well inside the edge of the Fortymile Caribou Herd's recent annual range, which would be a particular concern to subsistence users.

With the exception of caribou and moose, however, the area between the Pogo Mine site and a hypothetical Slate Creek Mine site is outside recent Upper Tanana Athabaskan subsistence use areas. The area is within the lifetime subsistence use area for caribou and upland birds. Although such a road from Pogo to a Slate Creek Mine would not in itself have a major impact on current subsistence uses because it is outside of current subsistence use areas, subsistence users likely would perceive it as a further cumulative encroachment on the "wilderness" to the north, and another step toward connecting to the Taylor Highway and "surrounding" the village of Healy Lake with roads and modernization.

Construction of a new road represents a classic fear of cumulative impacts from a road, because, in the view of the subsistence workshop attendees (SRB&A, 2001), "roads beget more roads." The land use policies that would permit a road to the Pogo Mine site could do likewise for other resource developments, and through the Alaska Industrial Development and Export Authority (AIDEA) or other vehicle might even help fund more roads. Thus, retaining an all-season road to Pogo could have a major cumulative impact on subsistence resources. These impacts, however, could be mitigated if the State of Alaska undertook appropriate land and resource management policies for the area that would limit public access to, and impacts on, subsistence resources.

4.14 Cultural Resources

In this section, cultural impacts are discussed in the context of guidelines contained in Section 106 of NHPA (36 CFR 800). These guidelines define the process for considering effects on cultural resources by projects that use federal moneys or permits. No high impacts to cultural resources are expected from project development.

Losses of cultural resources normally occur from primary effects, such as destruction from project activity where no information has been gathered. Secondary effects may include increased pedestrian travel over cultural resource sites and uses of newly created access that result in unauthorized visitation or, at worst, site looting.

If impacts to a site cannot be avoided, damages may be mitigated through archaeological data recovery. Archaeology is a study that involves the removal from the ground or final resting place of information to a processing and analysis laboratory. A site may be physically removed, but the information, including measurements, photographs, and matrix samples, is salvaged through careful removal techniques and scientific inquiries. Important artifacts can be removed for preservation in perpetuity. Reconstruction of the site occurs in the completion of reports about the excavation and inquiries. Thus, while sites and artifacts may be taken from their surface and subsurface placement, information such as who lived at the site, their activities, and the importance of the site lives on through careful documentation and recording.

EPA, as lead federal agency, in consultation with COE and SHPO, has determined that some cultural resources sites may meet the following three criteria: (1) they could be eligible for the National Register of Historic Places (NRHP) under 36 CFR 60.4; (2) they could be adversely affected by construction of the Pogo project; and (3) they have not yet been mitigated under permits previously issued by the SHPO. These sites, therefore, could require mitigation through data recovery under a programmatic agreement (PA) among the EPA, COE, Advisory Council on Historic Preservation, SHPO, and Teck-Pogo Inc. The PA contains provisions for discovery of prehistoric, historic, and paleontological remains during construction, operation, and closure of the Pogo Mine. A draft of the PA is contained in Appendix F.1.

The following is drawn from Harritt (2002) unless otherwise indicated.

4.14.1 No Action Alternative

Depending on the particular project, DOF timber sales or land-altering construction projects, such as a natural gas pipeline, upgrade of the GVEA Fairbanks-Delta power line, or DOF forest road construction, would be subject to SHPO review either under NHPA Section 106 or the Alaska Historic Preservation Act before construction could commence. Municipal land may undergo the same type of process, at the discretion of the city, but private land development is not subject to Section 106 review unless the development involves federal funds or permits.

Gradual increases in the numbers of houses and recreational uses of the area and an increase in private residential land sales could eventually result in damage to cultural resources as house sites and surrounding properties are developed. Increased recreational use of the project area such as seasonal hunting and fishing would increase the likelihood that artifacts present on the surfaces of sites would experience an additional degree of vulnerability to looting and other types of damage.

Overall, impacts to cultural resources from the No Action Alternative would be low.

4.14.2 Options Common to All Alternatives

Based on the documented cultural resources sites in the mine site vicinity, the large majority of mine facilities would have no effect on known cultural resources (Yarborough, 2000; Teck-Pogo Inc., 2002a). It is possible, however, that unknown resources could be present. The State of Alaska plan of operations approval would stipulate that in the event cultural resources were discovered as a result of construction, development, or operation of the Pogo project, activities at that location would be stopped until the SHPO was consulted and an evaluation of the resource could be carried out.

Facilities on the Goodpaster Valley floor near the existing portal, however, including the existing advanced exploration camp, existing airstrip, gravel pit clearing, and explosives storage, are located relatively close to XBD-184, a prehistoric surface feature. Although this site is across the Goodpaster River from these facilities, they would present a situation in which that site could be vulnerable to inadvertent or secondary damage. Such damages could result from activities related to further development and operation of the facilities or from intentional disturbance caused by looting activities. To protect the resource from such an impact, a rudimentary data recovery effort may be prescribed as a requirement of Section 106 compliance.

Definitive locations for potential domestic and industrial water wells, however, have not yet been identified. To meet Section 106 requirements, prospective well locations would be located only in areas that would not affect cultural resources. It is anticipated that cultural resources can be protected by modifying locations of these facilities where necessary. If a particular well could not be located to avoid adverse effects on the cultural resources, data recovery would be carried out to meet Section 106 compliance requirements prior to drilling.

4.14.3 Options Not Related to Surface Access

Impacts to cultural resources for the options not related to access would be similar to those described above for options common to all alternatives. To meet Section 106 requirements, locations of these options would be reviewed by the SHPO to determine effects on cultural resources. It is anticipated that cultural resources could be protected by modifying locations of these facilities where necessary. If a particular site could not be located to avoid adverse effects on the cultural resources, data recovery would be carried out to meet Section 106 compliance requirements prior to construction.

4.14.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- Three cultural resources sites have been documented along the Shaw Creek Hillside all-season road and power line routes, all east of Keystone Creek: XBD-246, a historic trapper's camp; XBD-235, a house depression, cache pits, and hearth scatters; and XBD-247, buried, prehistoric hearth material (Yarborough, 2001). XBD-235 has been determined to be eligible for the NRHP, while XBD-246 and XBD-247 were determined not to be eligible for listing. After this site was identified, the Shaw Creek Hillside all-season road alignment was altered and placed approximately 200 ft from the XBD-235 site area. Therefore, no effects to this site are anticipated.

  Evaluations of potential impacts on sites XBD-246 and XBD-247 cannot be completed until determinations have been made concerning NRHP eligibility. In the opinion of the field investigator these sites likely would not be eligible. If they were determined to be eligible, however, then alteration of the road and power line alignments to avoid these sites, similar to the one made for XBD-235, would result in a finding of no impact, regardless of whether the sites were eligible for the NRHP.

  As in the case of XBD-235 described above, alteration of planned modifications to avoid damaging the documented resources would result in a finding of no impact, regardless of whether the sites were eligible for the NRHP. Alternatively, in the event modifications to the road had to be made, measures would be required to mitigate damage to the resources.

  - Shaw Creek/Rosa egress There are seven documented sites in the area: XBD-015, graves and caches; XBD-031, a prehistoric lithic scatter site; XBD-071, prehistoric Meade site; XBD-130, reported site designated as BM Shaw; XBD-131, early man Broken Mammoth site; XBD-157, a prehistoric lithic scatter; and XBD-200, the Fowler Farm archaeological site 4. Some sites are clearly eligible for the NRHP; others have not been evaluated. Therefore, if upgrading activities were to occur, Section 106 may require an archaeological compliance survey and/or data recovery prior to initiating such modifications of this route segment.

  - Tenderfoot egress This option would avoid the highest concentration of known cultural resources located near the Richardson Highway. Determination of potential impacts on cultural resources cannot be made, however, until an actual route is established. If this egress sub-option were selected, a field compliance survey and review by the SHPO would be conducted to meet the requirements of the Section 106 process. If this sub-option were constructed, the road would provide access to areas where cultural sites are located, increasing contacts with these resources and thereby increasing the likelihood of looting and other types of damage to the sites.

Use and Disposition Restricting the use of any portion of the access road during Pogo project operations, or after project closure, would mitigate likely damage to cultural resources by limiting the number of people traveling through the area and thereby reducing opportunities for looting. The fewer the users, the less likely impacts would occur to cultural resources.

Any further modification to the terrain along the route related to the removal and reclamation of the road would be subject to the Section 106 review process that should protect cultural resources.

Alternative 3

Surface Access

Route

- Only a single isolated chert flake has been documented along the South Ridge all-season road and power line corridor (Yarborough, 2000). The location where the flake was found does not have high potential for containing cultural resources because of the distance to a water source, among other factors.

  If this access option were selected, a review of the South Ridge corridor would be required by the SHPO prior to initiation of construction activities. Also, any modifications to the existing Quartz Lake and DOF roads would require such a review prior to initiation of modifications of those roads.

  If the South Ridge access corridor option were constructed, it would provide access to areas where cultural sites are located, increasing contacts with these resources and thereby increasing the likelihood of looting and other types of damage to the sites.

Use and Disposition Effects from restricting use of the road during mine operations and after mine closure, and from removal and reclamation of the road, would be the same as for Alternative 2.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter-only access This route would use the existing TAPS access road located one-half mile south of Shaw Creek on the northern side of the Richardson Highway. Because this segment of the route has not been surveyed, if this option were selected, a field compliance survey and review by the SHPO would be conducted to meet the requirements of the Section 106 process.

  Of particular concern in this area would be potential impacts of the project on XBD-016, the Shaw Creek II site, which contains protohistoric and historic graves and cache features. The winter road/trail route would not affect known cultural resources on Shaw Creek Flats. From its intersection with the Shaw Creek Hillside all-season road route, effects on cultural resources would be the same as for Alternative 2.

4.14.5 Cumulative Impacts

- All-Season Road Reclaimed Absence of an all-season road would limit other resource development activities and human access, and would result in essentially no cumulative impacts on cultural resources.

- All-Season Road Maintained Almost all lands in the project area, including those on which the Pogo Mine project would be developed, are owned by the State of Alaska. All development, therefore, would occur with protection of cultural resources through the Section 106 process and AS 41.35. Most cumulative impacts, therefore, would occur just from human presence. Thus, the expected increase in population in the Delta area, coupled with Pogo Mine development, would slowly increase the potential for impacts to cultural resources. Recreational use of the state lands in particular would increase that potential.

  If an all-season road were maintained after completion of Pogo Mine operations, it would increase the potential for cumulative impacts on cultural resources from human activities. Additional mineral development beyond the proposed project would further increase potential cumulative impacts by either extending the period of active mining, as under the scenario of finding additional reserves at Pogo or development of the hypothetical Sonora Creek mine, or simply by increasing the number of active mines as under the hypothetical Slate Creek mine scenario. If a road to a Slate Creek Mine were constructed and open to public use, the potential for impacts to cultural resources would further increase.

4.15 Visual Resources

The relative level of potential visual impacts of the project components was identified and evaluated based on the combination of visual quality and integrity, visual absorption capability (VAC), and viewer sensitivity values. The severity of visual impacts was considered in the context of landscape changes noticeable to viewers looking at the landscape from their homes and recreational cabins, or from parks, recreation, or preservation areas, highways, ATVs, aircraft and other travel modes, and other important cultural sites and features.

The following viewers have been identified as potentially having a high regard for the scenic integrity of the project area:

- Cabin owners along the Goodpaster River
- Residents and travelers along the Richardson Highway
- Residents and travelers along Shaw Creek Road
- Clearwater Lake residents and visitors
- Quartz Lake residents and visitors
- Other recreational users of the area, including backcountry and airborne viewers

Visual contrast is defined as a measure of physical change in the landscape that would result from introduction of a project (USFS, 1995). For example, the presence power line H-poles, transportation access routes, mill and camp facilities, tailings disposal site, and other ancillary facilities of the Pogo Mine project would cause physical change in the landscape. The severity of visual impacts was determined by analyzing how these changes would be viewed and perceived from sensitive viewpoints. Certain factors are considered and incorporated when analyzing visual contrast and impacts to sensitive viewers. These factors include:

- Distance — The contrast of project-related changes is usually less as viewing distance increases.
- Angle of observation — The apparent size of a project-related change is directly related to the angle between the viewer's line of sight and the slope on which the project change would occur.
- Duration of view — If the viewer has only a brief glance of the change, the contrast may not be of great concern. If the change is subject to view for a long period of time, however, the contrast may be very high.
- Relative size and scale — The contrast created by the change is directly related to its size and scale in comparison to the surroundings in which it is placed.
- Light conditions — The amount of contrast can be substantially affected by the light conditions. The direction and angle of lighting can affect color intensity, reflection, shadow, form, texture, and many other visual aspects of the landscape.

Visual contrast levels are analyzed by combining landform/vegetation contrast levels with structure (project component) contrast levels. These contrast elements are described as:

- Landform/vegetation contrast — The change in vegetation cover and patterns that would result from construction activities.
- Structure contrast — The compatibility of the proposed project component with other structures in the landscape and the existing natural landscape.

Generally, strong visual contrasts in the landscape viewed from high-sensitivity viewpoints within 1 mile would result in high visual impacts. Visual impact levels generally get lower as visual contrasts become weaker or as the distance from the viewpoint increases. These contrasts are defined as:

- High — Strong and moderate visual contrast associated with the presence of a project component or construction activities associated with the project that are visible from high-sensitivity viewpoints (e.g., recreationists and other users in the upper reaches of the Goodpaster River) within the 0- to 0.5-mile distance zone.
- Moderate — Weak visual contrasts visible from high-sensitivity viewpoints within the 0.5- to 1-mile (e.g., foreground) distance zones and strong or moderate visual contrast visible in the 1- to 3-mile (e.g., Goodpaster Winter Trail and Quartz Lake users, and Shaw Creek Road residences adjacent to the proposed Shaw Creek Hillside route) distance zone.
- Low — Weak visual contrast visible from high-sensitivity viewpoints within the 1- to 3-mile distance zone and strong, moderate, or weak contrast visible within the 3-mile and beyond (e.g., travelers along the Richardson Highway viewing the Shaw Creek Flats and Hillside routes and the Goodpaster River cabin owners) distance zone. Lower scenic quality impacts would result.

Clearing of vegetation for the power line and access routes and the actual presence of these and other project components would contrast with the natural setting of the existing environment, especially in those areas outside the Richardson Highway corridor. The contrast would vary, however, depending on its distance from the viewpoint, duration of view, and scale of the component related to the existing environment.

The visual analysis also used USGS digital elevation data (terrain data), land cover information, and photographs taken with a 35-millimeter lens during a time of year that leaves were off the deciduous trees to capture views when potential changes would be most visible.

Following is a discussion of the potential impacts on visual resources. The nine simulated views within the Pogo Mine project area represent typical constituent views of the access components.

4.15.1 No Action Alternative

The No Action Alternative would result in probable visual impacts from other projects in the Delta area, including: a natural gas pipeline; construction of the NMDS; and the DOF's 5-year plan forestry road in the Shaw Creek drainage.

A natural gas pipeline would require clearing of vegetation in a corridor close to the TAPS ROW near the Richardson Highway. Highway travelers would not consider this additional ROW clearing in the same general location to be a high impact.

Commercial, industrial, and private land sales and development would increase because of the NMDS. Formerly natural, undeveloped areas would be cleared to provide locations for these new land uses, and there would be high long-term impacts on visual resources.

The DOF's 5-year timber sale plan in the Shaw Creek drainage and Quartz Lake areas would require clearing of vegetation, all-season road development, and harvesting of various stands of timber. Some of these changes in visual quality and scenic integrity could be substantial to backcountry, recreational, or airborne viewers.

Components of these projects would be visible in foreground, middle-ground, and background views. Generally, the observed visual impacts would be higher in the foreground views and less substantial in the middle-ground and background views. The concern levels, scenic class, and scenic integrity of visual resource areas also describe the importance of the probable visual impacts.

For example, the Quartz Lake area has a low scenic class rating due to visible development and infrastructure around the lake with distinctive scenic attractiveness and a moderate level of scenic integrity in the foreground views; however, the concern level is high. The middle-ground views also have a high concern level, but are considered a moderate scenic class and have very high existing scenic integrity. Quartz Lake scenic resources have been affected by the Division of Park's existing parking lot and boat ramp facility. The DOF's planned road development around Quartz Lake would not substantially affect the views of concerned viewers, including existing residents of, and visitors to, Quartz Lake because even though the concern level is high, the road should not be viewable from the lake.

Overall, visual impacts from the No Action Alternative would be low.

4.15.2 Options Common to All Alternatives

Liese Creek valley has been identified as a visual resource area with high scenic values, distinctive scenic attractiveness, and provides viewers with distinctive foreground and background views. The location of the existing exploratory mining operation is considered to have low to very low scenic integrity. The disposal of tailings above ground in the valley would have higher impacts on the existing visual resources than would underground disposal. Views of above ground tailings piles would have high visual impacts to recreationists because of the low VAC of the area due to slope and topography.

The dry-stack tailings pile would be evident to viewers from the air, and in certain areas from the ground and river. The distance and duration of the viewpoints, however, would determine the importance of the view of this distinctive landscape. Airborne viewers would be substantially affected by the tailings location. The dry-stack tailings pile likely would be relatively well screened by vegetation from viewers on the Goodpaster River, and impacts would be low.

Recreationists would have obscured foreground and middle-ground views of the mill and camp development in an area with distinctive foreground and background views while traveling down the Goodpaster River. Airborne viewers also would have obscured views of the mill and camp development due to the valley's slope and topography. These views would not cause high visual impacts to recreationists floating the river, but could cause moderate impacts to airborne viewers desiring a totally primitive experience.

Mitigation measures could include use of additional screening vegetation and materials to adequately buffer the tailings, mill, and camp developments from sensitive viewpoints. There would be unavoidable impacts to scenic resources from the tailings pile that could not be mitigated.

Continued use of the airstrip at the end of the Pogo project also would have impacts to existing visual resources and scenic integrity. Backcountry users desiring a nonmotorized experience would see greater aircraft activity, as well as more recreational users, in the project area if the airstrip were open to everyone during and after the project's operation. Mitigation measures would include restrictions and limitations on the use of the airstrip.

4.15.3 Options Not Related to Surface Access

Alternative 2

Power Supply

- Power line A power line would have very substantial visual impacts because of the scale, distance, and viewer recognition of power poles compared to on-site power generation.

  Figure 4.15-1 illustrates a potential view of the Goodpaster River Bridge and power line near the mine site. The view of the bridge, looking downstream, would be the same for all alternatives; however, the view of the power line is specific only to Alternatives 2 and 3. The power line poles would have high visual impacts on airborne viewers of this stretch of the Goodpaster River, as well as viewers directly on or along the river.

Alternative 3

Power Supply

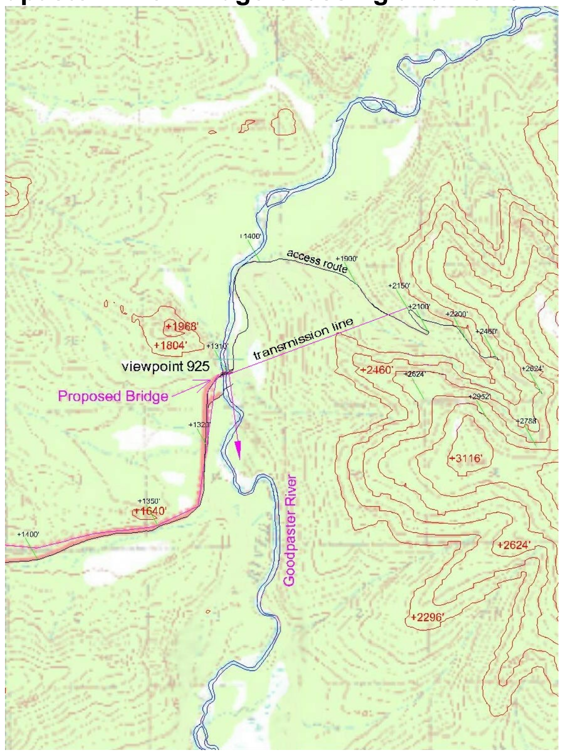
- Power line Same as Alternative 2.

Alternative 4

Power Supply

- On-site generation This option would require additional surface disturbance for fuel storage at the airstrip. This option would have moderate impacts on intermittent views of recreationists on the Goodpaster River. These impacts, however, would be substantially less than for a power line.

Figure 4.15-1 View of Goodpaster River Bridge Crossing and Power Line Route Near Mine Site



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4.15.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- The Shaw Creek Hillside all-season road and power line would be located in an area with predominately background views, high concern levels, moderate scenic class, and very high scenic integrity.

  The majority of the route is in an area of predominately high VAC. This siting of the route along lower elevations of the hillside would have low impacts on the visual resources in the area as viewed from the Richardson Highway. Views of the road and power line corridor, however, still would be evident to any concerned backcountry users and airborne viewers.

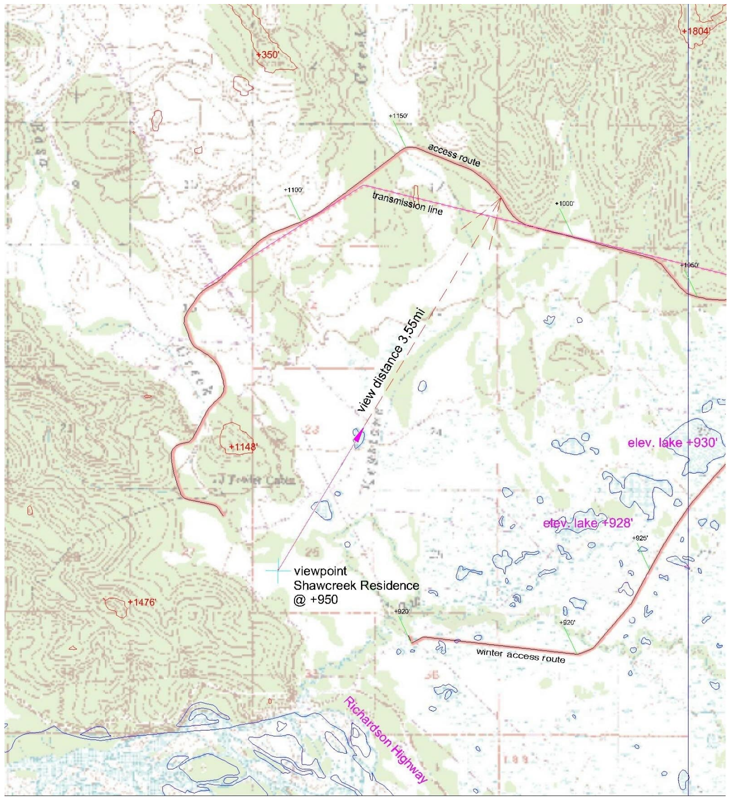
  Residents along the existing Shaw Creek Road also would be concerned viewers of this route. Figure 4.15-2 illustrates a potential view of the Shaw Creek Hillside access road and power line from a residence on Shaw Creek Road. The background views from this area would cause high visual impacts to existing residents due to their close viewing distance (approximately 3.5 miles) and the substantial contrast in natural landforms from development along the hillside. The power line poles would be visible, though minimally so. Although the road itself would not be visible, the line of vegetation cleared for the road would be visible against the base of the hills.

  Richardson Highway travelers also would be concerned viewers of this route. Figure 4.15-3 illustrates a potential view of the Shaw Creek Hillside access road and power line from the Richardson Highway. An existing GVEA power pole is in the foreground view of the figure, with distant views (approximately 5 miles) of the road and power line. This route would be only briefly visible intermittently to a highway traveler because there are dense vegetative screens along the edge of the highway, obscuring views across the flats and toward the hillside.

  Proper siting and development of the road and power line corridor within topographical considerations (i.e., at lower elevations), with adequate vegetative buffers/screens, where feasible, would mitigate visual impacts.

  - ✦ Tenderfoot egress The Tenderfoot egress option is located in an area with low VAC due to steep slopes and topography as viewed from the Richardson Highway. Development of this option would have moderate to high impacts on the visual resources in this area because of its low VAC and high viewer sensitivity.

Figure 4.15-2 View of Shaw Creek Hillside Road and Power Line Routes from a Shaw Creek Residence



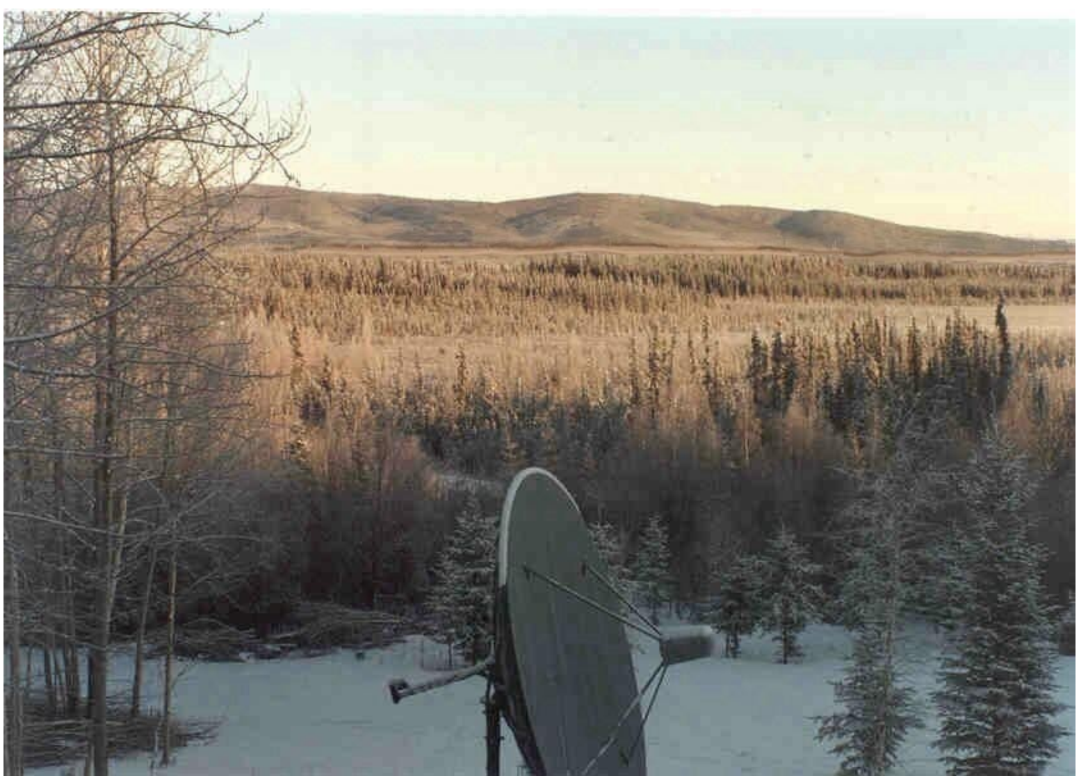


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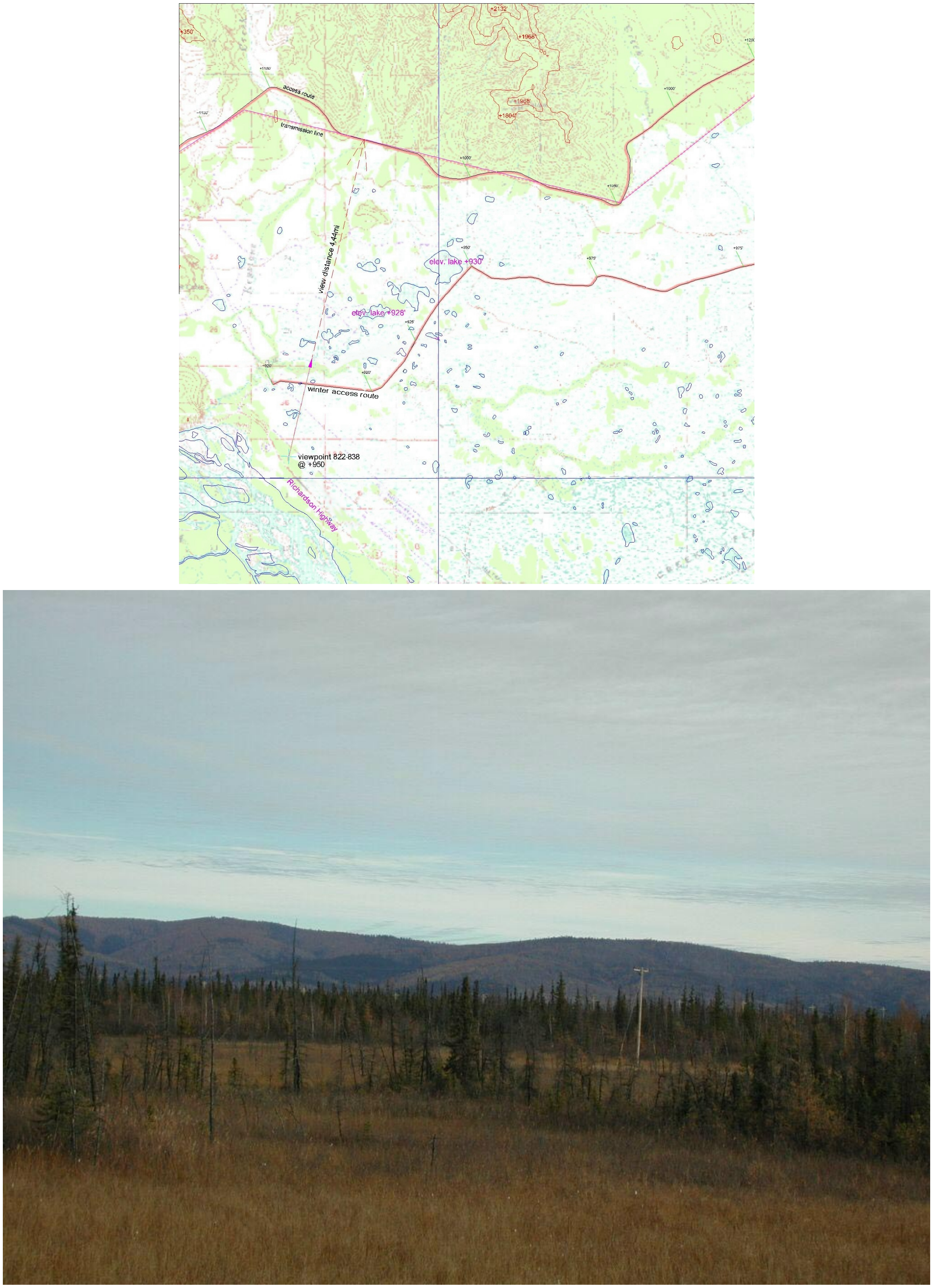
Figure 4.15-3 View of Shaw Creek Hillside Road and Power Line Routes from the Richardson Highway (Existing GVEA Power Line in Foreground)



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Use While visual impacts would be low from use only by Pogo-related traffic, additional impacts would occur if the route were open to other users. There would be greater disturbances (such as light and dust) potentially viewable for longer periods of time. Increased road dust would be generated, especially during dry seasonal conditions. There also would be an increase in vehicle lights in the late evenings, early mornings, and during other periods of low natural daylight, particularly in winter.

The other road use options would have an increasing impact on visual resources in the following ascending order: industrial/commercial users and open to everyone.

Disposition Removing the road and power line and reclaiming the landscape at mine closure would have the fewest impacts on currently existing visual resources. Current visual appearance would be restored as vegetation reclaimed the corridor over time, and there would be no traffic to generate light and dust impacts.

The other road disposition options would have an increasing impact on visual resources in the following ascending order: industrial/commercial users and open to everyone. The last category would have greater visual impacts (light, dust, and headlights) than for use only by the Pogo project because there likely would be more traffic.

Alternative 3

Surface Access

Route

- The South Ridge route is located in an area with predominately background views, high concern levels, moderate to high scenic class (Shaw Creek Dome), and very high scenic integrity. The route is primarily located in a zone with low VAC because of the visible higher elevations along the South Ridge slopes.

  Goodpaster River cabin owners, Goodpaster Winter Trail and other backcountry users, Clearwater Lake visitors, Richardson Highway travelers, Quartz Lake residents and visitors, and airborne viewers would be concerned viewers of this route.

  The route would have moderate to high impacts on visual resources in the area due to the low VAC and the sensitivity of concerned viewers and their proximity to foreground, middle-ground, and background views. The impacts to visual resources would be considered high to Goodpaster River cabin owners. Visual impacts would be higher than for Alternative 2, and would be inconsistent with the visual guidelines in TBAP.

  Figures 4.15-4 through 4.15-8 illustrate potential views of the South Ridge all-season road and power line routes from typical viewpoints at Goodpaster River cabins, near the Goodpaster Winter Trail, and the Quartz Lake and Clearwater Creek recreation areas.

  The view distances from the Goodpaster cabin locations, shown in Figures 4.15-4 and 4.15-5, would be greater than 9 miles. Background views of the road, but not the power poles, would be observable from these Goodpaster River sites, and visual impacts would be high to cabin owners, even though the viewing distance would be substantial. These concerned viewers are expected to be highly sensitized to any visual changes in the landscape because of their historical views of the natural landscape. Any impacts to existing visual resources, therefore, would be considered high by this user group.

  Figure 4.15-6 illustrates a potential view of the South Ridge Road and power line routes from the Goodpaster River Winter Trail at an elevation of approximately 1,200 ft.

Background views of the road and power line would be fairly visible because of the relatively short viewing distance (approximately 3.5 miles) and therefore would cause high visual impacts to winter trail users.

Figure 4.15-7 illustrates a potential aerial view of the South Ridge power line route from above Quartz Lake in the vicinity of a private dock on the north end of the lake. The potential road corridor would not be visible from the lake elevation in this area; however, the tops of power poles would be visible from the lake in the middle ground at a distance of approximately 2.5 miles. Locating the power line corridor more closely along the proposed road corridor (behind the highest elevation in this area) would eliminate this potential view.

Figure 4.15-8 illustrates a potential view of the South Ridge Road and power line route from the south portion of Clearwater Lake. The view distance is more than 15 miles. The road, but not the power line, would be visible. Even though there are few topographic landforms between Clearwater Lake and the potential route, the observed contrast, and its importance, would be substantially diminished because of the distance.

Mitigation would include the avoidance of steep slopes and cut banks where possible and use of construction methods that minimize steep bank cuts and erosion. Adequate vegetative buffers/screens along the length of the corridor and hydroseeding downhill slopes also would mitigate visual impacts. Some moderate to high impacts on scenic resources could not be avoided because of the disturbances to steep slopes and contrast between existing landforms and the road and power line.

Use Because the South Ridge all-season road and power line would have higher visual impacts than Alternative 2, use by others than the Pogo project would have correspondingly greater impacts than Alternative 2. The other road use options would have an increasing impact in the same ascending order as for Alternative 2.

Disposition Same as for Alternative 2, except that because the visual impacts of this alternative would be greater than for Alternative 2, they would remain longer before vegetation obscured them.

Figure 4.15-4 View of South Ridge Access Route from Cabin on Goodpaster River

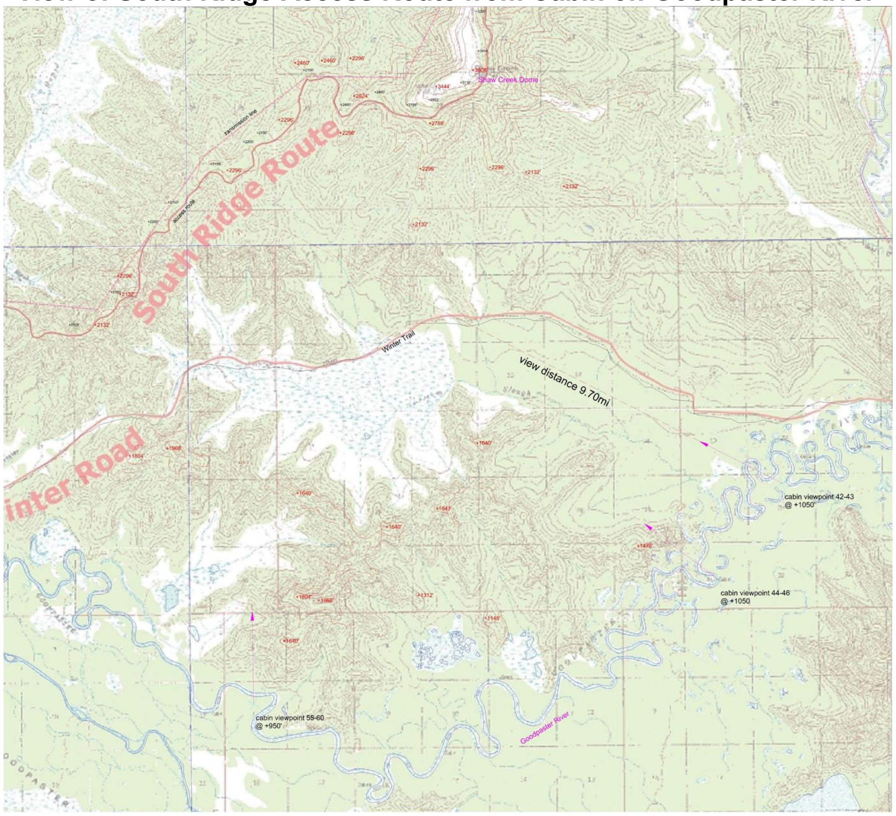

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Figure 4.15-5 Aerial View of South Ridge Access Route from Cabin on Goodpaster River

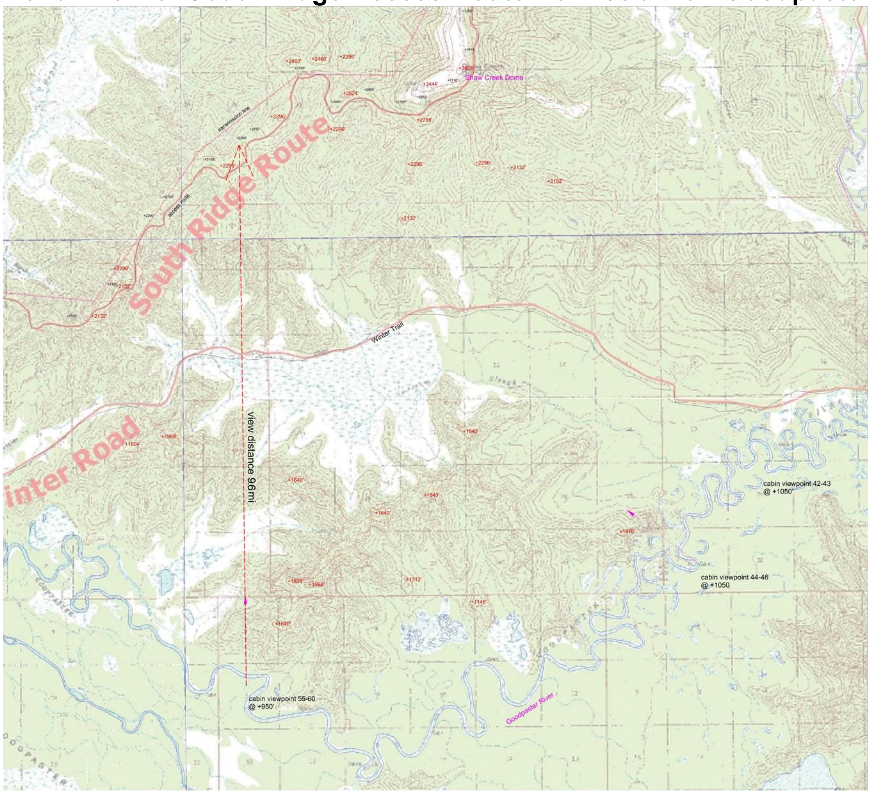

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Figure 4.15-6 View of South Ridge Access and Power Line Routes from Goodpaster Winter Trail

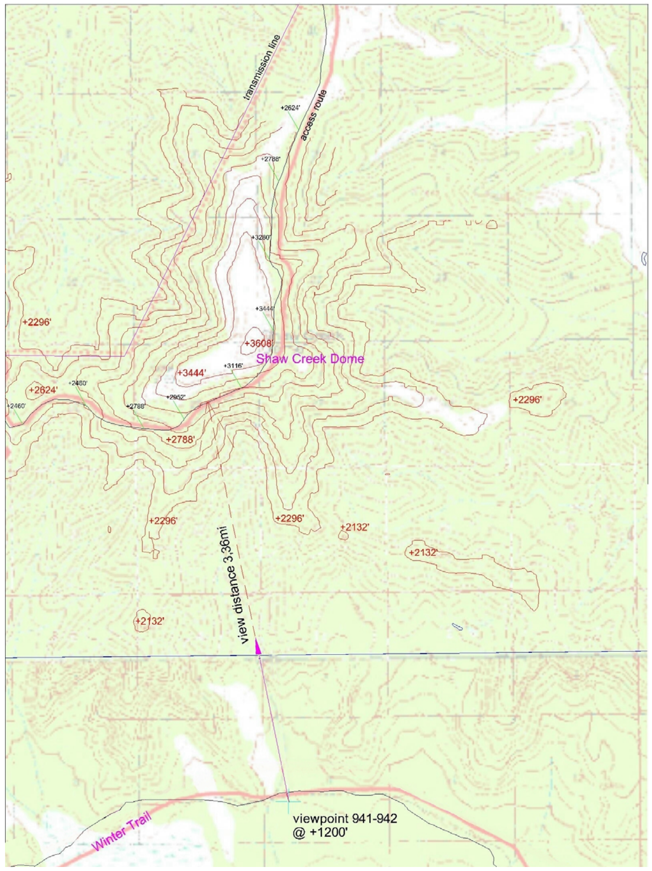

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Figure 4.15-7 Aerial View of South Ridge Power Line Route from Quartz Lake

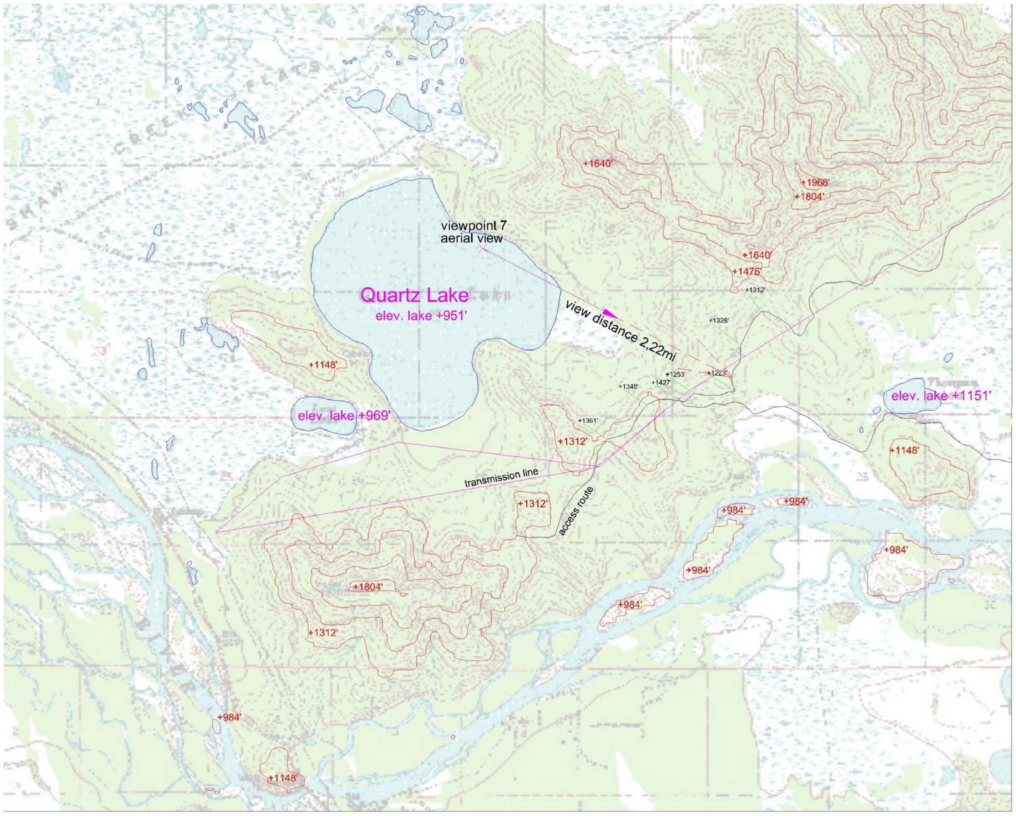

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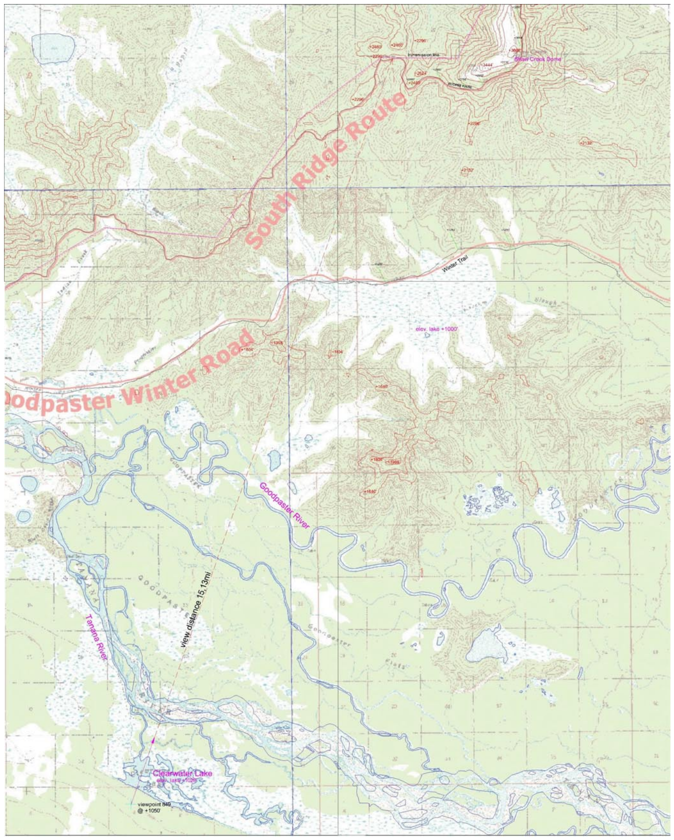
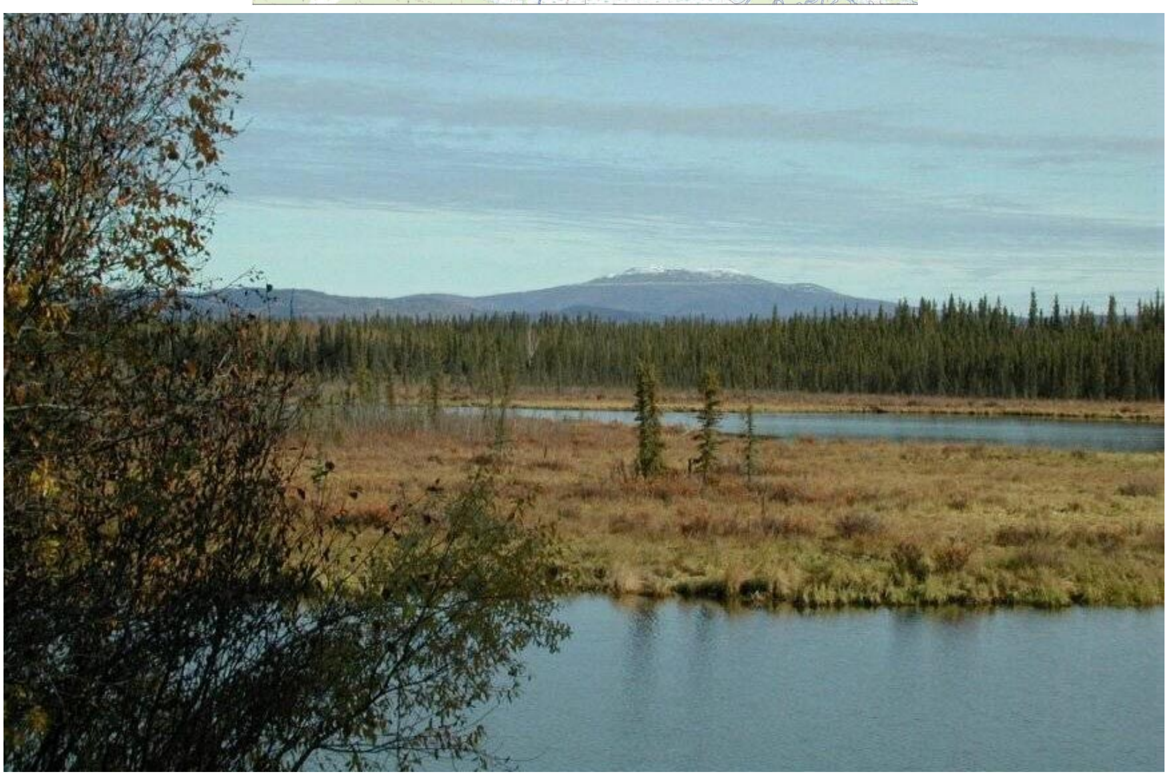
Figure 4.15-8 View of South Ridge Access and Power Line Routes from Clearwater Creek Recreation Area





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Alternative 4

Surface Access

Route

- The Shaw Creek Flats winter-only access route is located in an area with middle-ground and background views, high concern levels, moderate scenic class, and very high scenic integrity. The route across Shaw Creek Flats would not be visible from the Richardson Highway because of the low elevation of the flats and its high VAC.

  Overall, the road would have low impacts on scenic resources because of the high VAC of the Shaw Creek Flats and Hillside areas. Additional vegetative buffers/screens along the Richardson Highway corridor could mitigate any potential visual impacts.

Use Use of the winter-only access route by users other than the Pogo project would have low impacts on existing visual resources and scenic integrity because of the nature of a winter road/trail and its limited window of operations compared to the all-season road options in Alternatives 2 and 3.

Disposition Impacts for the all-season road segment would be the same as for Alternative 2. The winter-only access segment simply would not be used again for project purposes and would be available for use by anyone, much as a majority of the route is today.

4.15.5 Cumulative Impacts

- All-season Road Reclaimed Removal and reclamation of the all-season road would result in a slow restoration process as vegetation reclaimed the corridor over time, and there would be no or low cumulative visual impacts.

- All-season Road Maintained Components of the Pogo Mine project would contribute cumulatively to the visual resource impacts discussed above under the No Action Alternative.

  A hypothetical Sonora Creek Mine, within the Pogo claim block, and Slate Creek Mine, 25 miles northeast of Pogo in the upper Goodpaster drainage, would cumulatively contribute to impacts on existing scenic resources because of the clearing of natural vegetation for related surface and air access, power, and other mine-related facilities. Cumulative impacts from extension of the life of the Pogo project itself would be relatively small because of the impacts that would already have occurred in the mine vicinity.

  Road and power corridors to Pogo would provide the necessary infrastructure for the Sonora Creek Mine, and likely would provide a major portion of the infrastructure for the Slate Creek Mine, thus increasing potential industrial and commercial activities in these corridors.

  Such activities would have cumulative impacts on visual resources. A road extension from the Pogo mill to a hypothetical Sonora Creek Mine would be minimally visible from the Goodpaster River, and would not cause high visual impacts for river users. Because of its relatively short length and location close to the substantial Pogo infrastructure, it also would not cause a high visual impact to airborne viewers.

If a road were extended from Pogo up the Goodpaster Valley to a hypothetical Slate Creek Mine, however, the road extension could have a high visual impact to floaters on the river, as well as airborne viewers, in the context of the upper Goodpaster Valley.

Mine site facilities at both hypothetical mines would be in locations with low VACs because of steep slopes, lack of vegetation, and surrounding elevations. These mining facilities would contribute cumulatively to visual contrast in areas where existing natural vegetation is predominant. In the case of a Sonora Creek mine, these visual impacts would be high only to ground viewers within the context of the Sonora Creek drainage, but would not be high in a larger context to airborne viewers because of the proximity of the mine to the substantial Pogo infrastructure.

For a hypothetical Slate Creek Mine, visual impacts from mine site facilities would be high to ground viewers within the context of the Slate Creek drainage. In conjunction with a road up the Goodpaster Valley, these facilities would cause high visual impacts for airborne viewers within the context of the upper Goodpaster Valley.

4.16 Recreation

Severity of impacts with respect to recreation were considered in the context of whether the physical setting, social conditions, or available recreational activities and use areas (ROS classification) would be substantially affected by any components of the project.

Based on the ROS inventory data in Chapter 3 (Figure 3.17-5), some project options would cause changes to the existing physical setting and social conditions. While some changes would be small, some could be considered major by both existing and new recreational users.

Figure 4.16-1 combines existing recreation use areas, ROS classes, and Alternatives 2, 3, and 4 to display changes in ROS classes from those shown in Figure 3.17-5. If the physical setting, social conditions, or available recreation activities in the study area would be substantially affected by an alternative, the ROS class, and therefore recreational experience, would change accordingly (USFS, 1998).

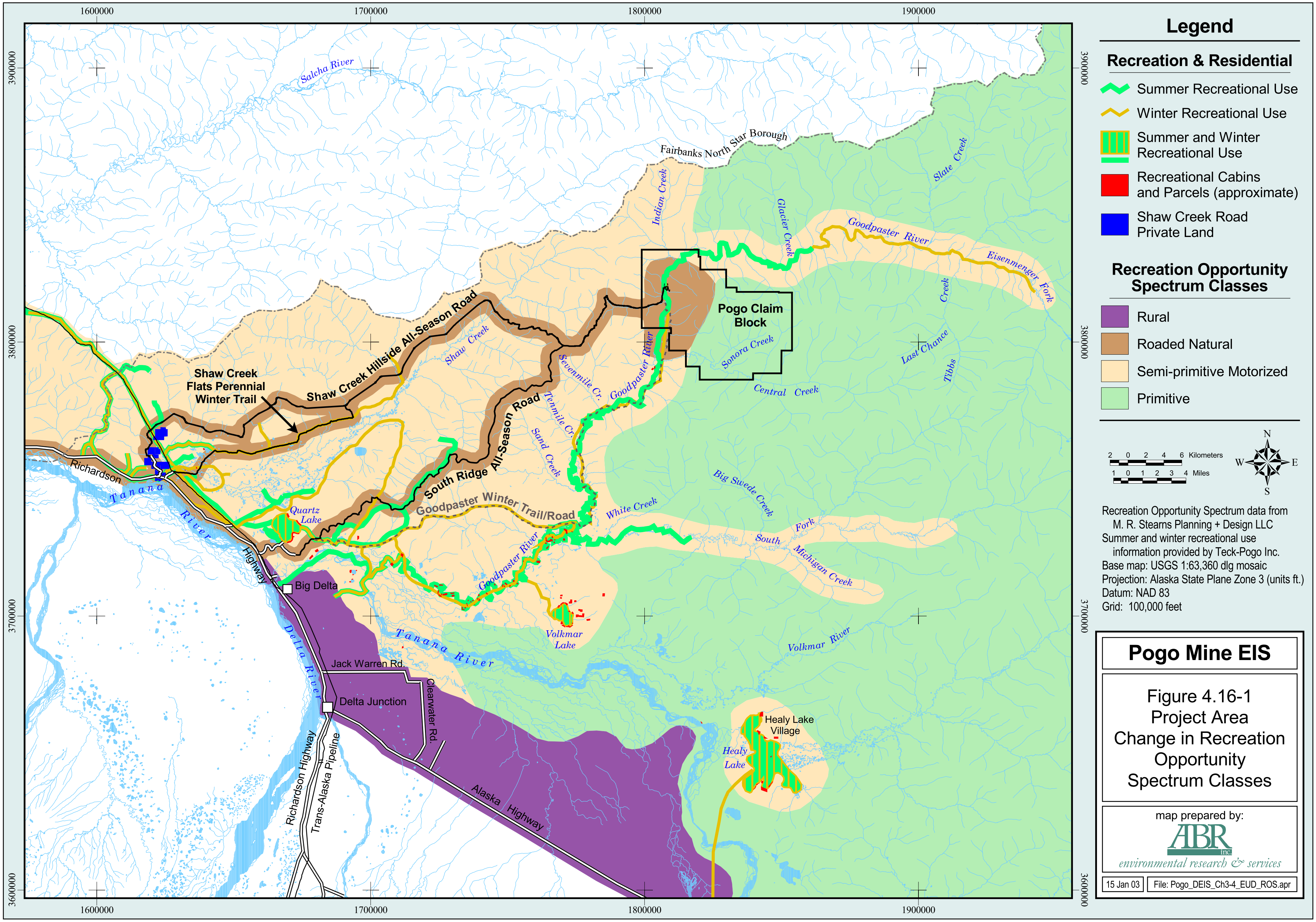
The introduction of new modes of access to the Pogo Mine project area would change the physical and social settings, as well as recreational activities and use areas, if the new access modes were made available to recreational users.

4.16.1 No Action Alternative

Scoping comments indicated the project area has a high value in terms of recreational resources. Recreation use likely would continue to increase, especially in areas already accessible to user groups.

The additional workforce in the Delta area, required by the NMDS and the proposed natural gas pipeline, would have a low impact on the existing recreational opportunities, recreation use areas, and recreation activities of the area.

Private residential land sales supporting the larger population would increase as a result of the NMDS, affecting some existing semi-primitive motorized ROS classes, especially those located near the Richardson and Alaska highways.



Legend
Recreation & Residential
Summer Recreational Use
Winter Recreational Use
Summer and Winter Recreational Use
Recreational Cabins and Parcels (approximate)
Shaw Creek Road Private Land
Recreation Opportunity Spectrum Classes
Rural
Roaded Natural
Semi-primitive Motorized
Primitive
Kilometers
Miles
N
S
E
W
Recreation Opportunity Spectrum data from M. R. Stearns Planning + Design LLC
Summer and winter recreational use information provided by Teck-Pogo Inc.
Base map: USGS 1:63,360 dlg mosaic
Projection: Alaska State Plane Zone 3 (units ft.)
Datum: NAD 83
Grid: 100,000 feet
Pogo Mine EIS
Figure 4.16-1
Project Area
Change in Recreation Opportunity Spectrum Classes
map prepared by:
ABR Inc.
environmental research & services
15 Jan 03
File: Pogo_DEIS_Ch3-4_EUD_ROS.apr
Salcha River
Fairbanks North Star Borough
Pogo Claim Block
Shaw Creek Flats Perennial Winter Trail
Shaw Creek Hillside All-Season Road
South Ridge All-Season Road
Goodpaster Winter Trail/Road
Goodpaster River
Big Delta
Delta Junction
Jack Warren Rd.
Clearwater Rd.
Alaska Highway
Richardson Highway
Trans-Alaska Pipeline
Tanana River
Delta River
Quartz Lake
Volkmar Lake
Healy Lake Village
Healy Lake
Volkmar River
Indian Creek
Glacier Creek
Slate Creek
Eisenmenger Fork
Sonora Creek
Central Creek
Last Chance Creek
Tibbs
Shaw Creek
Sevenmile Cr.
Tenmile Cr.
Sand Creek
Big Swede Creek
White Creek
South Fork
Michigan Creek
1600000
1700000
1800000
1900000
3900000
3800000
3700000
3600000

The DOF's 5-year timber harvesting plan would construct all-season road corridors in areas that are currently primarily primitive ROS class. This would open up areas in the Shaw Creek drainage to recreational users and affect its ROS class. Existing ROS classes would change from primitive and semi-primitive motorized to roaded natural and semi-primitive motorized. Because these roads would be open for public use, recreational access would be greater and easier. This increased access would have a high impact to existing recreational users in the vicinity of the forestry road, but would have a substantial positive benefit to prospective recreational users.

Overall, recreational impacts from the No Action Alternative would be low, except for areas accessed by the planned DOF forestry roads where recreational use would increase substantially.

4.16.2 Options Common to All Alternatives

The airstrip would be located in the semi-primitive motorized ROS class. If the airstrip were open to everyone during mine operations, and were to remain open after mine closure, it would be a substantial benefit to prospective recreational users, particularly to those desiring to hunt, fish, or float the Goodpaster River. Availability of an airstrip would have a low effect on existing recreational users of the mine area because there is currently little recreational use. Recreational cabin owners on the lower Goodpaster River, however, could be affected moderately by floaters and fishers who would float into the lower river past these cabins. Increased river use would alter their present isolation and could cause changes in fishing bag and size limits, as well as an increase in littering and vandalism.

4.16.3 Options Not Related to Surface Access

Alternative 2

Power Supply

- Power line A power line route would be located in roaded natural, semi-primitive motorized, and primitive ROS classes. The cleared power line ROW would provide a benefit of backcountry access for new motorized and nonmotorized recreational users, depending to what extent mitigation measures were implemented to limit access. This increased access, however, would have a high impact on existing recreational users. Mitigation measures would be used to limit ATV access along the power line ROW.

Alternative 3

Power Supply

- Power line Same as Alternative 2.

Alternative 4

Power Supply

- On-site generation The mine site would be located in the semi-primitive motorized and primitive ROS classes. On-site power generation would cause a small increase in noise and other activity levels in the vicinity of the mine and access route due to the generators and the additional fuel transportation requirements. This disturbance would have a low to moderate impact on primitive and semi-primitive motorized ROS classes.

4.16.4 Options Related to Surface Access

The existing ROS classes of the Shaw Creek Hillside route, the South Ridge route, and the Shaw Creek Flats winter-only access route are roaded natural, semi-primitive motorized, and primitive.

The changes to the ROS classes in the vicinity of the project would vary depending on the use of the road access (Pogo project only versus everyone) and the disposition of the road at the end of the Pogo project (reclaimed versus open for everyone).

For purposes of this analysis, Figure 4.16-1 illustrates the changes in ROS classes for Alternatives 2, 3, and 4 that unrestricted all-season road or winter-only access would produce.

Alternative 2

Surface Access

Use and Disposition Opening the Shaw Creek Hillside road just for the Pogo project or allowing only Pogo and other commercial/industrial users and then removing and reclaiming the road at the end of the Pogo project would have low impacts on existing recreational users, many of whom do not want an improved road (Ridder, 2002). Availability of the road would, however, have a high impact on prospective motorized recreational users. The cleared road and power line ROWs still could be available for motorized and nonmotorized recreational access for some time, however, even if they were removed and reclaimed.

Permanent access with the use of the Shaw Creek Hillside all-season road open to everyone could have a high impact on existing recreational users desiring remote and primitive recreational experiences because interactions with other recreational users would be greater due to increased access. A particular example would be the recreational cabin owners on the lower Goodpaster River. If the public were able to drive to the Goodpaster River Bridge near the mine site, it could become a popular launching site for floaters and fishers and bring them into the lower river and past these cabins. This river use could change the current relative isolation of the cabins, and could cause changes in fishing bag and size limits, and an increase in littering and vandalism.

If the Shaw Creek Hillside road were open to everyone during mine operations and after Pogo Mine closure, the primitive and semi-primitive areas traversed by the Shaw Creek Hillside route would change ROS class to roaded natural. Some areas adjacent to the Shaw Creek Hillside route in the valleys would change from primitive to semi-primitive motorized because these areas would now be accessible to a greater number of motorized recreational users.

- Richardson Highway egress The Shaw Creek/Rosa Richardson Highway egress option would have low recreation impacts to existing or prospective recreational users because Shaw Creek Road already exists. In a similar manner, the Tenderfoot egress option would have low recreation impacts on existing or prospective recreational users because this area already contains roads and trails, including a forestry road from the Richardson Highway and ATV trails beyond Rosa Creek.

- Security gate at Gilles Creek If the road were open for everyone, but with a security gate at Gilles Creek, the same impacts described above for road use by everyone would occur, but only in the lower two-thirds of Shaw Creek Valley.

Impacts to Goodpaster recreational cabin owners and other existing recreational users north of Gilles Creek would not occur. Potential recreational users, however, would not receive the benefits of easy access to the mid-Goodpaster River.

Alternative 3

Surface Access

Use and Disposition Impacts from the South Ridge all-season road would be the same as for Alternative 2, except the ROS class changes from primitive and semi-primitive to roaded natural would occur to areas traversed along the South Ridge route. In the same manner as for Alternative 2, areas adjacent to the South Ridge route, including higher elevations, would change from primitive to semi-primitive motorized because these areas would be accessible to a greater number of motorized recreational users.

Permanent all-season road access along this route could have slightly more impacts on the owners of Goodpaster Valley recreational cabins because parts of the access road would be visible from the cabins.

Alternative 4

Surface Access

Use and Disposition The changes to ROS classes would be the same as for Alternatives 2 and 3, except the changes would be seasonal. Because the specific purpose of the winter-only access option would be to limit public access to the Shaw Creek and Goodpaster valleys, it would not be open for public use.

Use of the winter-only access route by Pogo-related traffic or other industrial or commercial users would lower the quality of existing nonmotorized recreational experiences, but this impact would be limited to the area of the road corridor. Because this alternative would reduce the number of new recreational motorized vehicles, it would not affect traditional recreational experiences in the primitive and semi-primitive areas as much. Snow machines still would use traditional routes to access these areas, however.

There would be few impacts on the recreational cabin owners on the lower Goodpaster River because the Goodpaster River Bridge at the mine site would not be accessible to floaters and fishers, as would occur with a publicly accessible all-season road in Alternatives 2 and 3.

Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, as the DOF road, which would be open to the public, was extended toward Gilles Creek, recreational impacts from public use would begin to approach those described for Alternative 2.

4.16.5 Cumulative Impacts

- All-season Road Reclaimed Although removal and reclamation of the all-season road would result in a definite impact on new recreational users because access would be reduced, there would be no cumulative impacts.

- All-season Road Maintained Pogo mining activities, as well as the potential for extending the life of the Pogo project and the hypothetical Sonora Creek and Slate Creek mines, would substantially affect ROS classes in these areas. Primitive and semi-primitive motorized ROS classes would change to semi-primitive motorized and roaded natural.

If the road were open to public use, recreational access would increase and be easier as far as the headwaters of the Goodpaster River. Thus, if construction of an all-season road to Pogo were to occur and cause additional mines or other developments farther up the Goodpaster Valley, and if the road were open to public use, it could have a high cumulative recreational impact on existing recreational users as well as a high beneficial cumulative recreational benefit to prospective recreational users.

4.17 Safety

In this section, safety impacts are discussed in the context of workers as well as members of the public who could come into contact with project-related activities such as a winter or all-season road. Safety issues related to workers in the mine and mill and at other project facilities are not considered because they would be covered by specific MSHA regulations that are beyond the scope of this EIS.

4.17.1 No Action Alternative

Under this alternative, the DOF would construct all-season road access from the end of the existing Shaw Creek Road to three timber sales in the Fowler Creek and Keystone Bluffs areas. The number of log truck round trips per day on Shaw Creek Road would depend on the number of years it would take to harvest a particular sale. If only one sale area were being harvested actively, there would be an estimated two or three round trips per day. If all were being harvested simultaneously, there would be an estimated eight round trips per day.

Overall, safety impacts from the No Action Alternative would be low.

4.17.2 Options Common to All Alternatives

Increased traffic on the Richardson Highway would have negligible safety impacts; however, additional signing and possibly construction of turning lanes or lighting at the junction of the access road with the Richardson Highway might be necessary.

4.17.3 Options Not Related to Surface Access

No safety impacts were identified for the options not related to access.

4.17.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- Richardson Highway egress Use of the existing Shaw Creek Road as initial access to the Shaw Creek Hillside all-season road would cause some safety risk to residents of the six year-round residences accessed from the road. After the Shaw Creek Hillside all-season road was built, during intense periods of mine construction, traffic would average approximately 50 vehicles per day, roughly evenly split between semi-tractor trailers and light vehicles.

  During mine operations, there would be an estimated average of 10 to 20 mine-related vehicle round-trips per day on Shaw Creek Road, excluding shift change-related traffic. Depending on the project's particular needs, the number of trucks and other vehicles on a given day could be substantially higher than the average; on other days there might be few or no trucks or other vehicles.

If the Applicant's shift-change bus station were located near the TAPS crossing, there would be two, approximately one-hour periods every 4 days, during each of which up to 180 vehicles would traverse the road. If the bus station were located on the Richardson Highway, the number of vehicles during each of these periods would be reduced to approximately six buses. The former location option would have a higher safety risk along Shaw Creek Road than would the latter location.

Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State of Alaska has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. DOT/PF may have to conduct a traffic impacts analysis, in conjunction with issuance of a drive way permit, which may result in specific mitigation measures being required. Because the road could be upgraded in the future if necessary, speed limits could be adjusted if appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low.

If the Tenderfoot egress option were selected, the Shaw Creek Road safety issue would not be relevant. The Tenderfoot route, however, would require switchbacks that would introduce a different safety issue for that option.

If the all-season road were open to everyone during mine operations, and the existing Shaw Creek Road were used, a small increase in the same issue of safety risk to residents identified above would occur. The increased risk would be due to more traffic (public and logging operations), and because typical users likely would not be as observant of speed limits as would drivers under specific direction from the Applicant. The safety risk, while increased, would still be low. If the all-season road were to remain open to everyone after mine closure, this low risk would continue. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road.

- Security gate at Gilles Creek   If the road were closed to public use with a security gate near the end of the existing Shaw Creek Road, public use of the existing Shaw Creek Road would be restricted and impacts to residences would be low. If the all-season road were completely open to public use, traffic on Shaw Creek Road would increase substantially compared to that at present, and impacts would be increased. A security gate at Gilles Creek likely would reduce public use measurably because it would prevent access to the last half of the road, but traffic still would be considerably higher than if the security gate were located near the end of Shaw Creek Road. Safety impacts, however, still would be low.

Alternative 3

Surface Access

Route

- South Ridge all-season road   This alternative would have the same volume of Pogo-related traffic as Alternative 2. The safety-related issue would pertain to the approximately 2.1 miles of the Quartz Lake access road that would be shared with traffic generated by Quartz Lake cabin owners, fishers, boaters, snowmachiners, and other recreationists. This current traffic level is higher than that on Shaw Creek Road. In a manner similar to that described for Alternative 2, before the Pogo project would be able to use the Quartz Lake access road, the State of Alaska would review existing conditions and determine whether the road needed to be widened or otherwise upgraded based on its design criteria and the expected traffic volume and size of the vehicles, including expected logging truck traffic from proposed DOF timber sales. Although the road is currently somewhat narrow, because it would be upgraded if necessary, is well maintained, has been recently improved, and because the Applicant's policy would be to adhere to all speed limits, the safety risk would be low.

In winter, this route would subject traffic to higher winds, drifting snow, and poorer visibility than would the Shaw Creek Hillside all-season route because of its considerably longer segment above timber line.

Alternative 4

Surface Access

Route

- Shaw Creek Flats winter-only access Use of winter-only access would require movement of large volumes of supplies during a relatively short window under very cold and dark conditions that would be more likely to cause accidents. While similar work is done elsewhere in Alaska under these conditions, and the safety risk would be low, it would be a tangible risk and a higher one than that associated with an all-season road.

  If winter-only access were open to everyone, there would be a moderate safety risk. Maintaining traffic control under these conditions just for project trucks would be a challenge. If other users were to be on the road/trail at the same time, the chances of an accident, particularly with a snow machine, would be substantially higher. During the movement of supplies to the Pogo Mine site over the Goodpaster Winter Trail in 1997-1998, the Applicant had to have smaller warning vehicles at both ends of each convoy on this public trail to intercept other users.

4.17.5 Cumulative Impacts

- All-season Road Reclaimed Removal and reclamation of the all-season road would have no cumulative safety impacts.

- All-season Road Maintained If the Shaw Creek Road option for egress from the Richardson Highway were used, and the mine access road were open for use by everyone, there could be a cumulative safety impact on residences along Shaw Creek Road from public use and timber harvest-related traffic in addition to use by the Pogo project. If this status were maintained after mine closure, cumulative safety impacts likely could increase if other major developments, such as the hypothetical Sonora Creek and Slate Creek mines, were to occur and public use intensify. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road.

4.18 Technical and Economic Feasibility

Technical and economic feasibility impacts are discussed in this section in the context of whether they could be a major factor in the Applicant's decision about whether to construct the project, and whether they could serve as substantial economic impediments to long-term project stability. Although most options for a particular component had technical and economic advantages and disadvantages for the Applicant, few were considered different enough to warrant discussion.

4.18.1 No Action Alternative

This alternative is not applicable for the technical and economic feasibility criteria.

4.18.2 Options Common to All Alternatives

Gravel Source

Gravel is on the critical path for project construction. It would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option. Most of the nonmineralized rock that would be generated from underground would not be available until later in the two-year project development period. Underground mine development must follow completion of the appropriate surface facilities described above. Advancing underground development before beginning the surface civil works isn't possible because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable.

From another perspective, experience during the Pogo Mine exploration phase has demonstrated that underground development rock does not make a good traffic surface for high volume roads (Hanneman, 2003e). At the existing advanced exploration facilities, gravel has been used to top the surface of the high volume roads because the development rock breaks down under traffic loads and becomes mud. Thus, from a technical perspective, crushing development rock to make gravel would not be feasible or practicable. Also, a gravel road topping has helped to reduce sedimentation both on the surface and underground, where reduced sedimentation in the mine sumps has been an important factor in water treatment plant efficiency.

Another need for gravel may arise for topping portions of the mine access road. Test work at potential material sites along the proposed Shaw Creek Hillside road alignment has shown the rock in most of the proposed material sites does not conform to Alaska test method (ATM) T-13 degradation, or to Los Angeles Abrasion American Society for Testing and Materials (ASTM) C131-96 specification for coarse abrasion testing of coarse rock (Shannon and Wilson, Inc., 1999, 2000). Thus, while the rock from these sites would still be suitable for bulk fill, topping material with sufficient hardness for the road surface would have to be hauled long distances from select material sites. Two of the material sites may contain rock suitable for crushing and use for road topping, and it would be advantageous in some areas for the Applicant to do so rather than haul gravel from the vicinity of the mine. Some of the gravel from the mine area sites, however, could be used for access road topping.

Even if nonmineralized development rock were suitable for crushing, which it is not, the direct cost to produce approximately 140,000 cu yd of aggregate for use in the mine area would be approximately three to four times greater than mining pit run gravel by expanding existing borrow pits and developing new ones as proposed by the Applicant. A reasonable cost estimate for pit run gravel at the Pogo site is approximately $4 per cu yd. Thus, crushed development rock would cost between approximately $1.1 million and $1.7 million more than mined gravel (Rowley, 2002a).

4.18.3 Options Not Related to Surface Access

Tailings Facility Liner

Dry-stack tailings pile Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability perspective, however, a liner would be more problematic.

The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk. Overall, there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner.

Installation of an erosion control/drainage blanket before tailings would be placed in the dry-stack tailings facility was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation.

RTP The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities.

Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cutoff wall.

The proposed RTP dam face liner system and grout curtain would establish an effective interception cutoff wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock.

A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including:

- A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cutoff wall required to collect the subsurface seepage. If such a cutoff wall at the upgradient end of the liner were required, it would follow that another liner upstream of that cutoff wall also would be needed, etc. It is thus a cutoff wall perpendicular to the flow that would be needed to capture seepage, not a liner.

- Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume.
- The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V).

A full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage. From the economic perspective, if a liner were feasible, a very rough estimate for the cost of a full basin liner under the RPT is approximately $1.5 million.

4.18.4 Options Related to Surface Access

Alternative 2

Surface Access

Route

- Richardson Highway egress The Tenderfoot Richardson Highway egress option would require construction of an essentially new, approximately 3.5-mile road to the vicinity of the end of the existing Shaw Creek Road.

  Although constructible, the route would cross difficult terrain, with poor soils and likely permafrost. Deep incised gullies indicate loess deposits that would require deep side hill cuts. Ascent and decent segments would require 5 to 7 percent grades for approximately 1.5 miles on each side of the ridge. Switchbacks would be required, with several curves having a radius less than the design criterion for 500 ft, and possibly less than the minimum of 300 ft.

  No detailed estimate of the cost of constructing this road has been made, but a reasonable construction cost estimate would be between approximately $2.5 million and $3.0 million (Rowley, 2002b). This expense would be a substantial additional cost to be borne by the project to avoid using the existing public Shaw Creek Road.

Alternative 3

Surface Access

Route

- South Ridge all-season road Soil and topography conditions along the first several miles of this route are difficult. They are characterized by steep slopes, many small drainages, and probable ice-rich soils, compared with good terrain and soil conditions on the Shaw Creek Hillside route. The steep slopes and angular talus in the vicinity of Shaw Creek Dome along the South Ridge route likely would make construction difficult. The elevated and exposed terrain and severe winds experienced in the Delta region would make maintenance more difficult and driving more hazardous, especially in blowing snow conditions. This route would be expected to be available for use approximately 10 fewer days than would the Shaw Creek Hillside route.

Alternative 4

Surface Access

Route

- The Shaw Creek Flats winter-only access option is technically feasible in that an annual winter road/trail could be constructed between the Richardson Highway and an all-season road beginning in the vicinity of Gilles Creek. The major technical concern is whether such winter-only access would be useable for an adequate period of time so that the Applicant would be able to transport all the required supplies to the mine site each year. An analysis of the winter-only access option showed that to maximize the annual window of use, the perennial winter trail option was more favorable than a traditional winter road because the former could be constructed more quickly, lengthening the use window by up to 2 weeks (Metz, 2001a, 2001b). The perennial winter trail, therefore, would have fewer economic feasibility impacts than a traditional winter road because it would increase the probability of success for the annual winter resupply effort by up to 25 percent over a traditional winter road.

  From an economic feasibility perspective, a winter-only access option is more problematic. Constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-ft airstrip for the remainder of the year, raises many economic feasibility issues. These include (Teck-Pogo Inc., 2001c; Metz, 2002; Puchner, 2002):

  - There would be only a short window for mobilization of construction equipment and supplies for the development phase, including construction of the all-season road segment.
  - Annual resupply of almost a year's worth of fuel, equipment, and materials would have to occur during an 8- to 10-week window. For almost 10 months of the year, the project would be dependent solely on air support, which would be susceptible to weather interruptions and capacity constraints.
  - Capital costs for access were estimated to be approximately 53 percent higher. Storage for a year's worth of diesel, propane, cement, reagents, and other materials would have to be constructed and maintained at the mine site. There also would be costs for a cement storage facility at a Fairbanks bagging plant and a staging area near the winter trailhead. Power line construction would be more expensive because there would be 15 fewer miles of adjacent road. During construction, there would be additional costs such as air support for personnel, fuel, food, and supplies; equipment standby rental while waiting for demobilization the next winter; and extended project and contractor overheads.
  - Total annualized operating costs were estimated to be approximately 118 percent higher. Freight was estimated to cost approximately 60 percent more per ton with winter-only access. Personnel air transportation costs would be very substantial. There would be additional rental costs for idled shipping containers awaiting the next winter's resupply window. Cement would have to be bagged for shipment, rather than handled in bulk. And, there would be finance costs for the stored inventory. Power line maintenance would be more costly.

An additional concern is whether winter-only access could successfully resupply the mine site on an annual basis. The Applicant's study indicated that winter-only access might not be available in 1 out of 13 years. Metz (2002) indicated the Applicant's study may be optimistic in light of the continued warming trend for central Alaska documented by Osterkamp and Romanovsky (1999). The Applicant's study did not include data from the winters of 2000-2001 and 2001-2002, and does not account for the long-term climate warming indicated in weather records for Big Delta (USDI/Bureau of Land Management, 2002). The mean annual air temperature for Big Delta has steadily increased since 1977. Most of the warming is a result of warmer, milder winters in central Alaska. Metz concluded that the actual frequency of conditions allowing for an adequate winter-only access window may be even lower than indicated in the Applicant's study.

In final analysis, the decision to proceed with a project is based on the probability that investors assign to its economic feasibility and the risk that assumptions will change. Anything that cannot be controlled increases risk. Because factors such as the price of gold and the cost of borrowing already are outside the control of potential investors, minimizing other project risks becomes very important. While each individual aspect of a winter-only access option arguably may be technically and economically feasible, the option must be viewed as a whole. If some factor outside the Applicant's control (short, warm winter with little snow; flooded airstrip; forest fire; or major equipment breakdown unable to be replaced by airlift) caused just one aspect of that option to fail, it could have serious economic consequences for the project. This susceptibility to factors that could affect economic stability greatly concerns investors because roadless isolation of the mine site would provide very little backup safety margin.

Thus, winter-only access would add capital and operating costs, increase the project's economic burden, and introduce an unreasonable level of complexity and business risk. The increased economic burden and unreasonable business risk were considered to have a major impact on the economic feasibility of the project.

4.18.5 Cumulative Impacts

Cumulative impacts are not applicable for the technical and economic feasibility criteria.

4.19 Cumulative Impacts

4.19.1 Tabular Summary of Cumulative Impacts

As defined earlier, cumulative impacts result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonable foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative impacts can result from individually minor impacts that, when viewed collectively over space or time, can produce significant impacts.

Examination of the cumulative impacts identified in the individual resource sections earlier in this chapter showed that the overwhelming factor determining cumulative impacts was whether the all-season access road would be removed and reclaimed at Pogo Mine closure or would be maintained for other resource development purposes and/or for public use. This factor applied not only to Alternatives 2 and 3, which contain a complete all-season road by definition, but also to Alternative 4 with its winter-only access option. Applicability to all three action alternatives results because it would be highly likely that, by the time of Pogo Mine closure, the planned

DOF road would have been constructed to the point that it would connect to the all-season road segment of the winter-only access option and be effectively operated like the complete all-season road options for Alternatives 2 and 3. Thus, the critical issue affecting cumulative impacts was not a choice of which alternative; rather, it was a management issue. That is, at Pogo Mine closure, would the road be removed and reclaimed, or would it be left in place for other resource development purposes and for public use?

Therefore, rather than present a summary of cumulative impacts on an alternative basis, Table 4.19-1 summarizes the impacts from a resource-by-resource perspective on the basis of whether the all-season access road would be removed and reclaimed at Pogo Mine closure or maintained for other resource development purposes and public use.

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.1 Surface Water Hydrology	
Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on hydrologic flow regimes of surface water.	Development of timber resources, mining, and public recreational and other uses all would have potential impacts on the surface water hydrologic regime that could be cumulative with the activities of the Pogo Mine project. Extension of the life of the Pogo project, development of hypothetical Sonora Creek and Slate Creek mines, or other resource developments occurring because of continued existence of an all-season road, individually would cause surface hydrologic impacts of a nature and magnitude similar to those from the proposed Pogo Mine project. Given their likely physical separation in different watersheds, the State of Alaska's management and regulatory tools, and the individual small impacts to the surface water hydrologic system, these mines and other resource developments would have low cumulative impacts on hydrologic flow regimes of surface water.
4.2 Groundwater Hydrology	
Absence of an all-season road would limit other resource development activities and human use and would result in very low cumulative impacts on ground water.	Cumulative impacts on groundwater resources in the area could result from development associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. Assuming sound management practices and permitting stipulations, and because such development activities would be distributed over such a large area, there would be low cumulative impacts on ground water.
4.3 Water Quality	
Absence of an all-season road would limit other resource development activities and human use, and would result in very low cumulative impacts on water quality.	Cumulative impacts on water quality could result from increased traffic associated with timber harvesting, extension of Pogo Mine life, and development of the hypothetical Sonora Creek or Slate Creek mines. During road extension construction, disturbed surfaces could erode and increase sediment in runoff that could cause increased suspended sediment in waterways. Such increased sediment and turbidity levels would be temporary and could be mitigated by the proper use of BMPs during construction and revegetation. These impacts cumulatively would be small. Additional transport of fuel, chemicals, and ore would increase risk of an accident and subsequent release that could affect water quality. The degree of increased risk would be proportional to the increase in commodity transport. If discharges from the hypothetical mines were similar to those projected from Pogo, slight increases in concentrations of a few parameters could occur, but the differences would be difficult to detect under most flow conditions. Overall, water quality cumulative impacts from maintaining the road would be low.
4.4 Air Quality	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts on air quality other than those of fugitive dust associated with road reclamation.	Although there would be minute impacts in the general area of any other developed project as a result of long-range transport of air pollutants, the distances between projects likely would be such that air quality emissions of any one project would not affect the ability of any other projects to be permitted. The permitting processes are used to ensure that cumulative impacts of new as well as existing projects do not result in exceeding the NAAQS and AAAQS standards. The construction and use of new access roads to the hypothetical Sonora Creek and Slate Creek mines

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
	would generate additional fugitive dust during construction and operation of the roads themselves as well as other facilities associated with these hypothetical projects. Fugitive dust also would be generated by an airstrip associated with a new Slate Creek mine. Such fugitive dust impacts would be small and limited to the local area. Overall, air quality cumulative impacts from maintaining the all-season road would be very low.
4.5 Noise	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative noise impacts other than those associated with road reclamation.	The primary area for cumulative noise impacts concern would be at the residences located along the existing Shaw Creek Road. With continued all-season road operation, it would be possible that traffic could increase substantially over time from logging, other industrial/commercial developments, and a road be open to the public. For a least one residence on Shaw Creek Road, this cumulative increase could approach a high impact In other areas, noise from road use and scattered developments is not projected to result in any high local long-term noise impacts. There may be times in certain areas, however, when cumulative noise from different sources could result in a substantial, temporary short-term noise level increase.
4.6 Wetlands	
Absence of an all-season road would limit other resource development activities and human access. Cumulative wetland impacts to the time the road was removed would include those from the Pogo project itself, the road to the mine, and off-road ATV use from the road. These impacts would be moderate with the Shaw Creek Hillside all-season road and low with the South Ridge all-season road, in the context of the Shaw and Goodpaster drainages.	Mine developments such as a hypothetical Sonora Creek mine would increase wetland impacts, but the location of the hypothetical mine close to the Pogo project's infrastructure would limit those impacts to an assumed 75 acres. A hypothetical Slate Creek mine accessed by extension of the Pogo all-season road would directly eliminate an assumed additional 200 acres of wetlands, including some of high value in the Goodpaster River Valley. Impacts would be limited through permitting processes. The maintained road would accelerate timber harvests. Although these harvests would focus on uplands, roads would require some wetland crossings, including impacts to valuable slope and riverine wetlands. Effects would be greater with a Shaw Creek Hillside all-season road than with a South Ridge all-season road because more timber harvests likely would occur in the Shaw Creek drainage, which contains more wetlands. An all-season road open to everyone would cause a moderate cumulative impact to wetlands in the Shaw Creek and Goodpaster River drainages. A few hundred acres of wetlands would be eliminated; a few hundred more would be slightly degraded by proximity to commercial and industrial structures and activity; and more would be severely degraded by recreational and subsistence activities, particularly those employing ATVs. While the impacts would affect a small proportion of the wetlands in the Shaw and Goodpaster drainages, the effects would be detectible on the scale of those drainages. Wetland impacts related to residential and commercial land development near the Richardson Highway would continue to be stimulated by ongoing resource extraction and public use activities associated with the road.
4.7 Surface Disturbance	
Not applicable.	Not applicable.

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.8 Fish and Aquatic Habitat	
Absence of an all-season road would limit other resource development activities and human use, and would result in essentially no cumulative impacts to fish and aquatic habitat.	Direct and indirect cumulative impacts would occur from extraction of timber and mineral resources, and increased recreational use from access opportunities and population growth. Although impacts could be minimal in any one occurrence, over time these impacts cumulatively would result in habitat loss and smaller, though still viable, fish populations. The brunt of this cumulative impact would fall on recreational users of the Goodpaster River through more restrictive regulations on fish harvest and possibly access. Additional mineral development would increase risks due to land disturbance and upsets from accidents and natural events. A hypothetical Slate Creek mine would involve an additional 25 miles of road on the Goodpaster River Valley floor adjacent to the river. Proper design, construction, and permitting stipulations, as well as State of Alaska management practices, could mitigate such risks. Overall, cumulative impacts would be moderate, and high only locally.
4.9 Wildlife	
Absence of an all-season road would reduce considerably resource development and related direct and indirect cumulative impacts on wildlife, particularly caribou.	Cumulative direct impacts to habitat, birds, and mammals under the TBAP from scattered timber and mining resource developments could be high on a scattered local basis, but would be low in the context of the Shaw Creek and Goodpaster River valleys. If these developments were connected by an all-season road it likely would increase resource development further, which could have a moderate cumulative indirect habitat effect on some wildlife species. A likely effect of increasing mineral exploration and development activity would be harassment of wildlife by aircraft, both intentional as well as unintentional, particularly by low-flying helicopters. In combination with general, nonmineral-related aviation, and the USAF's aerial combat training, these activities could substantially increase cumulative impacts on caribou. Of particular concern would be disturbance to the Fortymile Herd during its critical calving period. Extension of an all-season road to a hypothetical Slate Creek mine would expand year-round human activities and push the perimeter of habitat fragmentation to the edge of the herd's summer range. It is not possible to predict the degree of cumulative indirect habitat loss because road extensions and developments are only speculative; however, based on the likely mineral potential of the area, the State of Alaska's constitutional directive to develop its resources, the existing TBAP, and the history of Alaska road development in general, additional cumulative indirect impacts would be very likely.
4.10 Threatened and Endangered Species	
There would be no cumulative impacts on threatened or endangered species. Absence of an all-season road would substantially reduce cumulative impacts on sensitive species.	There would be no cumulative impacts on threatened or endangered species. Cumulative impacts on sensitive species would occur, especially if the road were extended to a hypothetical Slate Creek mine. The degree of cumulative impacts is not possible to predict because future developments are speculative.

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.11 Socioeconomics	
Absence of an all-season road would lower the probability for other resource developments in the project area, and could slow long-term economic growth based on such development.	By end of decade, with construction of the NMDS and/or a natural gas pipeline and Pogo, a cumulative total of between ~430 and 605 new permanent jobs could be added to the local economy for substantial positive economic effect. Most of the increase would be due to NMDS. Total Delta area population would rise to ~ 2,300 to 2,400. Pogo would directly or indirectly account for between 11 and 15 percent of population, a substantial effect. Estimated personal Delta area income would increase from ~$45 million in 2000 to ~$52 million to $54 million. The cumulative effect on local schools could be substantial, and demand for other public services also would increase, though not necessarily at a rate proportional to population increase. Although housing availability could be tight during NMDS construction, longer term cumulative effects on local housing market generally would be positive, resulting in increased valuations and additional housing construction. At the same time, local rental rates could rise.
4.12 Land Use	
Absence of an all-season road would limit other resource development activities and human use, and would change then existing land uses by removing the access that had allowed for mining development.	Cumulative impacts would be low because all uses likely would be compatible with adopted land use plans. *Changes* to existing land uses, however, could be substantial. A road to a hypothetical Slate Creek mine likely would cause changes to existing land use even though such change would be compatible with adopted land use plans. Remote reaches of the upper Goodpaster River would become more economically accessible to new commercial/industrial land uses, possibly opening up other adjacent mining areas in the future. Existing trappers, recreationists, and other users of the area likely would consider such infrastructure a substantial change to existing land uses, while new commercial and industrial land users would consider such infrastructure a substantial benefit.
4.13 Subsistence	
Absence of an all-season road would considerably reduce resource development and recreational access to subsistence use areas that are currently difficult to access, and thus would have substantially fewer cumulative impacts.	Direct subsistence impacts of a hypothetical Sonora Creek mine would be similar to those for the Pogo Mine because of its closeness to the Pogo Mine infrastructure. A Slate Creek mine near the headwaters of the Goodpaster River accessed by an all-season road would provide even greater access into a currently inaccessible area, especially if open to use by everyone. Such a road would extend well inside the edge of the Fortymile Caribou Herd's recent annual range. Road extension into the herd's range is a particular concern of subsistence users. With the exception of caribou and moose, however, the area between the Pogo Mine site and a hypothetical Slate Creek mine site is outside recent subsistence use areas. Although a road to such a mine would not in itself have a high impact on current subsistence uses because it is outside of current subsistence use areas, subsistence users likely would perceive it as a further cumulative encroachment of the "wilderness" to the north and another step toward connecting to the Taylor Highway and "surrounding" the village of Healy Lake with roads and modernization. Construction of a new road represents a classic fear of cumulative impacts from a road, because, in the view of the subsistence workshop attendees, "roads beget more roads." The land use policies that would

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
	permit a road to the Pogo Mine site could do likewise for other resource developments, and through AIDEA or another vehicle might even help fund more roads. Thus, maintaining an all-season road could have a major cumulative impact on subsistence resources. These impacts, however, could be mitigated if the State of Alaska undertook appropriate land and resource management policies for the area that would limit public access to, and impacts on, subsistence resources.
4.14 Cultural Resources	
Absence of an all-season road would decrease human presence considerably, and surface artifacts and other cultural resources would be less vulnerable to looting and other types of damage.	No major cumulative impacts would be expected from major developments because adherence to cultural-resource protection procedures under CFR 800, Section 106, would be required. Because additional road users would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage if the road were maintained after Pogo Mine closure, cumulative impacts could be increased. If a road to a hypothetical Slate Creek mine were open to public use, the potential for impacts to cultural resources would further increase.
4.15 Visual	
Removal and reclamation of the all-season road would result in a slow restoration process as vegetation reclaimed the corridor over time, and there would be no or low cumulative visual impacts.	Hypothetical mines developed because the all-season road were maintained would cumulatively contribute to visual impacts because of natural vegetation clearing for surface and air access, power, and other mine-related facilities. A road extension from Pogo to a hypothetical Sonora Creek mine would be minimally visible from the Goodpaster River, and would have low visual impacts for river users. Because of its relatively short length and location close to the substantial Pogo infrastructure, the road extension also would have low visual impact to airborne viewers. Visual impacts from mine site facilities themselves would be major only to ground viewers within the context of the Sonora Creek drainage, but would be low in a larger context to airborne viewers because of proximity of the facilities to the substantial Pogo infrastructure. A road extension up the Goodpaster Valley to a hypothetical Slate Creek mine could have a high visual impact to floaters on the river, as well as airborne viewers, in the context of the upper Goodpaster Valley. Visual impacts from mine site facilities themselves would be high to ground viewers within the context of the Slate Creek drainage. In conjunction with a road up the Goodpaster Valley, these facilities would have a high visual impact to airborne viewers within the context of the upper Goodpaster Valley.
4.16 Recreation	
Although removal and reclamation of the all-season road would result in a definite impact on new recreational users, there would be no cumulative impacts because there were no other current or foreseeable future actions identified that also would reduce access for recreation in the project area.	Pogo mining activities, as well at the potential for extending the life of the Pogo project and the hypothetical Sonora Creek and Slate Creek mines, would substantially affect ROS classes in these areas. Primitive and semi-primitive motorized ROS classes would change to semi-primitive motorized and roaded natural. If the road were maintained and open to public use, and if additional mines or other developments occurred further up the Goodpaster Valley, recreational access would increase to these locations. Thus, road maintenance and public use could have a high cumulative recreational impact on existing recreational users as well as a high beneficial cumulative recreational benefit to prospective recreational users.

Table 4.19-1 Summary of Cumulative Impacts

All Season Road Removed and Reclaimed at Mine Closure	All Season Road Maintained at Mine Closure for Other Resource Development Purposes and Public Use
4.17 Safety	
Removal and reclamation of the all-season road would have no cumulative impacts on safety because there were no other current or foreseeable future actions identified that also would reduce safety issues in the Shaw Creek Road area.	If the Shaw Creek Road egress option were used and the road were open for use by everyone, there could be a cumulative safety impact on residences along Shaw Creek Road from public use and timber harvest-related traffic in addition to use by the Pogo project. If this status were maintained after mine closure, cumulative safety impacts likely would increase if other major developments were to occur and public use were to intensify. These impacts could be mitigated by ADOT/PF traffic management measures on both existing Shaw Creek Road and the all-season road
4.18 Technical and Economic Feasibility	
Not applicable.	Not applicable.

4.19.2 Cumulative Impacts Summary Discussion

This subsection summarizes the cumulative impacts (Table 4.19-1). It first discusses cumulative impacts for the options common to all alternatives, and then discusses impacts for the options that differ between the alternatives.

- **Options common to all alternatives** The options common to all alternatives are shown in Table 2.5-1. Each option is for a project component located in the immediate vicinity of the mine site itself. Because of their small geographical distribution, the nature of the options themselves, and the design, construction, and mitigation measures that would be used to build and operate them, their impacts are largely localized. Thus, for all resources, cumulative impacts from these common options were determined to be low or nonexistent. Because by definition these options would be used regardless of which alternative were selected, cumulative impacts attributable to the proposed project were limited to the options that differ between alternatives.

- **Options that differ between alternatives** The options that differ between alternatives are shown in Figure 4-1. As discussed above in Section 4.19.1, examination of the cumulative impacts identified in the individual resources sections earlier in this chapter showed that the overwhelming factor determining cumulative impacts was whether the all-season access road would be removed and reclaimed at Pogo Mine closure or would be maintained for other resource development purposes and for public use. Thus, cumulative impacts in Table 4.19-1 were presented in that manner. This subsection summarizes those impacts for the removal/reclamation of the all-season road versus maintaining the road.

  - **Remove and reclaim the all-season road** Without exception, the removal / reclamation option was deemed either to reduce cumulative impacts for resources or to have no effect on cumulative impacts. For the majority of resources, simple lack of access by people and a lower probability of further resource development were the basis for the reduced cumulative impacts.

  - **Maintain the all-season road** For nine resources (surface water hydrology, groundwater hydrology, water quality, air quality, noise, threatened and endangered species, land use, cultural resources, and safety), cumulative impacts were considered low or very low, assuming continued state and federal regulatory controls, state management under existing land use plans, and implementation of appropriate mitigation.

    For two resources, socioeconomics and new recreational users, cumulative impacts of continued access would be beneficial.

    For the remaining six resources as a group, impacts generally would be low or moderate within the context of the entire project area, but could be high locally. This group included fish, wildlife, existing commercial users, subsistence, visual, and existing recreational users. Of particular importance affecting the level of cumulative impact for a given resource was continued state management under existing land use plans, whether the all-season road would be open for public use, and implementation of appropriate mitigation.

4.20 Mitigation, Reclamation, and Monitoring

Mitigation, reclamation, and monitoring measures proposed by the Applicant to reduce environmental impacts of the Pogo Mine project are described in Section 2.3 (Applicant's Proposed Project). These measures, as a minimum, would be used to ensure there would be no unreasonable impacts from project development, operation, and closure.

4.20.1 Mitigation

CEQ regulations in 20 CFR 1508.20 define mitigation to include avoiding, minimizing, rectifying, and reducing impacts. These regulations also provide for compensation by providing substitute resources or environments. The Applicant has built into its proposed project many mitigation measures that have been taken into account in assessing the environmental consequences of the alternatives in this chapter. These measures are identified in Section 2.3 (Applicant's Proposed Project) for each project component and are summarized in Table 4.20-1.

4.20.2 Reclamation

The overall goal of Pogo Mine closure and reclamation would be to return disturbed land to the designated post-mining land use, defined by the TBAP as public recreation and wildlife habitat (ADNR, 1991). The reclamation plan calls for re-establishing wildlife habitat within 5 to 15 years by stimulating growth of an early successional vegetation.

Section 2.3.27 (Closure and Reclamation) of this EIS summarizes the Applicant's goals and objectives for reclaiming disturbed areas after Pogo Mine closure. That section also summarizes more specifically how nine major mine components would be reclaimed.

The more detailed and site-specific closure and reclamation measures are presented in a separate document titled *Pogo Project Reclamation and Closure Plan* (Teck-Pogo Inc., 2002c).

4.20.3 Monitoring

Monitoring is a process by which adherence to various permit standards and stipulations may be assessed. Ultimate monitoring plans for operation, closure, and post-closure would be developed in conjunction with state and federal agencies during the permitting process that would follow the EIS process.

Although many permit requirements may be monitored, water quality is of particular concern. Section 2.3.28 of this EIS summarizes the Applicant's approach to ensure protection of the water quality of the Goodpaster River.

Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures

Component or Resource	Mitigation Measure
Milling process	♦ Gravity recovery, flotation, and concentrate leach to minimize ore exposure to cyanide (despite up to 2 percent lower gold recovery). ♦ Only 10 percent of all ore exposed to cyanide (minimizes sulfide and arsenic mineralization in surface dry stack). ♦ Cyanide leach circuit is contained in mill (not leached in outdoor exposed heaps). ♦ All exposed tailings undergo cyanide destruction.
Tailings disposal	♦ All tailings exposed to cyanide returned underground to mine as paste backfill after cyanide destruction process. ♦ Half of all other tailings also returned underground as paste backfill. Minimizes size of surface dry stack. ♦ Nonmineralized development rock used for berms. ♦ Tailings placed in the dry-stack structural shell during nonfreezing conditions when compaction can be ensured. ♦ Dry-stack access/haul road from mill would be progressively buried as tailings are deposited; thus, no rerouting of this haul road would be necessary.
Development rock disposal	♦ Mineralized development rock encapsulated within dry-stack tailings pile to minimize oxidation of sulfides and keep all runoff within treatment system. ♦ Nonmineralized rock used for general mine facilities construction (roads and pads) or also deposited in dry-stack tailings pile.
Gravel sources	♦ Timber more than 8 in. in diameter at breast height would be sawed and used for construction or support activities or would be salvaged for haulage off-site. ♦ Organic material consisting of surface vegetation, stumps, and root wads would be segregated and stockpiled. ♦ Silt and sand overburden would be segregated and stockpiled. ♦ In thawed areas, gravel mining would be conducted by dragline to increase digging depths and reduce the surface disturbance required. ♦ Shoreline length and diversity would be maximized to the extent practicable. ♦ The gravel pit locations have been selected to provide appropriate setback distances from the Goodpaster River.
Water quality	♦ Interception of all noncontact surface runoff and rerouting around facilities. ♦ All contact runoff from elevations above the RTP would drain into the RTP for treatment before discharge. ♦ Minimization of erosion from tailings dry stack by creating convex face of stack and sloped benches to collect sediment runoff and divert to perimeter ditches. ♦ Compaction of the dry-stack surface and use of silt fences if necessary to limit or direct runoff. ♦ Recycling of mill process water. ♦ Mill with concrete berms to contain and collect all spills inside building for disposal or return to processing tanks. ♦ Minimization of volume of water discharge. ♦ Reagents transported to site in appropriate packaging inside shipping containers for protection against spills. ♦ Cyanide containers tracked from arrival on site until empty containers returned to suppliers for refill. ♦ All domestic wastewater treated with ADEC-approved package treatment plants.
Wastes	♦ Disposal of settled solids from sumps, ditches, degritting basins, and the water treatment plant in paste backfill and dry stack; and of dewatered water treatment

Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures

Component or Resource	Mitigation Measure
	plant sludge (including sludge currently stored underground) in the paste backfill and in the general placement area of the dry stack. ♦ Construction of a surface landfill on site near the dry stack to dispose of other nonhazardous waste products such as dewatered sewage sludge, incinerator ash and residue, iron (e.g., drill steel, balls, and empty cans), tires, empty plastic and glass containers, empty triple-rinsed chemical containers, contaminated soils, spill boom, liners used for the containment of spilled materials, chemicals used in the cleanup of spills or other spill cleanup wastes, and construction debris. ♦ Use of an incinerator near the kitchen complex to incinerate all kitchen wastes and other cardboard, paper, and burnable wastes from throughout the project. ♦ Removal for off site disposal of some waste, including screen material containing wood chips and carbon from the CIP and rougher concentrate screens, semi-autogenous grinding mill liners, acid containers, and cyanide shipping containers that would be returned to the producer for reuse.
Fuel supply	♦ Tanker drivers trained in road safety and emergency response. ♦ Trucks would carry emergency response equipment. ♦ Enforced speed limit appropriate to road conditions. ♦ All vehicles in radio contact with mine dispatch center and other vehicles on the road system. ♦ Trained environmental response team to respond to spills and other emergencies.
Fuel storage	♦ All tanks contained in a bermed area with 110 percent capacity of the largest tank. ♦ Mobile vehicle refuelling at self-contained portable stations throughout mine area equipped with catch basins with sufficient fuel spill containment capacity. ♦ Fuel piping above ground wherever practicable, with leak detection and collection systems.
Stormwater	♦ Design and construction of drainage ditches as required by EPA stormwater regulations, ADEC water quality regulations, and ADNR and COE BMPs. ♦ Provision of spill planning, spill control materials, and response teams to rapidly control oil, chemical, or other spills that may affect stormwater. ♦ Segregation and stockpiling of organic material (surface vegetation and root wads) and growth media for future use. ♦ Protection of these growth media piles from wind and water erosion through seeding and use of BMPs. ♦ Reclamation of disturbed areas as soon as practicable after disturbance, including regrading, topsoil establishment, revegetation with approved seed mixes and plantings, and maintenance of reclaimed areas. ♦ Maintenance of roads and traveled areas to minimize erosion. ♦ Grading of roads and disturbed areas so that flows are directed to appropriate control facilities; maintenance of grading frequently.
Surface disturbance	♦ Minimization of facilities' footprint. ♦ Power line ROW that closely follows all-season road ROW to minimize construction and maintenance disturbance. ♦ Balancing of cuts and fills wherever possible.
Air quality	♦ Power supplied by power line, not generated on site. ♦ Compaction of tailings dry stack, limiting of surface traffic, and building of silt fences in nonactive areas in low-humidity conditions. ♦ Road dust minimized by enforcing low traffic speeds, with surface treatment with water or chemicals as needed.

Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures

Component or Resource	Mitigation Measure
Wetlands	♦ To the extent practicable, siting of facilities and the all-season road to avoid wetlands, minimization of wetland impacts where avoidance was not practicable, and mitigation of wetland impacts that would occur. ♦ Clearing only within fill footprint on flat wetlands. ♦ Use of frequent cross culverts under roads to maximize maintenance of natural drainage conditions. ♦ Use of measures to prevent erosion at culvert inlets and outlets. ♦ Establishment of vegetation on road cut and fill slopes to minimize erosion. ♦ Use of other appropriate techniques in ditches and on cut slopes to prevent erosion.
Fish	♦ Bridges over major creeks would be single spans ♦ Culverts sized and angled to allow fish passage ♦ No fishing policy for employees who were transported to the mine site on company-provided transportation.
Wildlife	♦ Gravel pits excavated and maintained with appropriate pit slopes to ensure stability and avoid wildlife entrapment. ♦ No hunting and trapping policy for employees and contractor personnel transported to the mine site on company-provided or contractor transportation. ♦ Employees must commute to mine by bus or air. No personal ATVs, snowmachines, boats, or planes. ♦ Enforcement of appropriate traffic speeds to reduce vehicle collisions with wildlife. ♦ An employee education program would be implemented that would include the following policies: ◇ Feeding animals would be strictly prohibited. ◇ Employees would be instructed in proper food handling and garbage disposal techniques, the personal dangers involved in feeding animals, and the fact that animals often end up being shot when they lose their fear of people and become dangerous. ◇ Every employee would receive formal instruction on how to avoid attracting and confronting bears. This would include: + Reading a handout that spells out the Applicant's bear policies and specifically lists forbidden activities (e.g., feeding wildlife, tossing out lunch wrappings and juice cans, harassing wildlife), and the risks of engaging in those activities (mauling, rabies). + Watching a video on how to avoid and react to bear encounters. + Reading ADFG's *Bear Facts* pamphlet. ◇ Employees would be instructed that if a bear is shot for reasons attributed to feeding of animals or the improper disposal of food away from camp, and the individual(s) can be identified, they would be disciplined. ◇ Employees would be instructed that any bear not shot in defence of life and property would be considered a violation of the Applicant's no hunting policy, the individual(s) would be disciplined, and the matter would be turned over to the Alaska State Troopers for investigation. ◇ Employees would be required to sign a statement affirming the employee understands the Applicant's animal feeding and bear policies and the consequences of violating those policies, including possible dismissal. ♦ The Applicant would develop and maintain animal-human contact protocols addressing: ◇ How to react to the presence of a bear that remains in the project area,

Table 4.20-1 Summary of Applicant's Proposed Project Mitigation Measures

Component or Resource	Mitigation Measure
	whether attracted by food, garbage, or for some other reason. ◇ When specific actions are needed, what actions should be taken, by whom, with what equipment, where it is stored, and what role (if any) agency personnel should play (e.g., ADFG). ◇ Applicant and agency personnel to be contacted for assistance or to report an incident. ♦ Organic and other food-related wastes would be stored in secured areas and then incinerated, with the burned residue buried to avoid attracting bears. ♦ Bird-power line collision mitigation includes: ◇ Limiting pole height to approximately 70-ft height would mean the lines themselves likely would be below the tops of trees. ◇ Horizontal cross member H-pole construction would separate the lines by more than 15 ft laterally and substantially reduce the chance for electrocution. ◇ This design also would allow line wires to be strung on one horizontal plane rather than at different elevations vertically. ◇ Phase wires would be of the same diameter, and no overhead ground wire is proposed for the lower geographic elevations nearer waterfowl areas. ◇ Wires would have daytime visual markers where they crossed Shaw Creek and the Goodpaster River.
Subsistence	♦ All-season road open only to Pogo-related vehicles. Gated, video monitored, and patrolled to ensure compliance. ♦ No public access to airstrip. ♦ No hunting, fishing, or trapping policy for employees and contractor personnel transported to the mine site on company-provided or contractor transportation. ♦ Employees must commute to mine by bus or air. No personal ATVs, snowmachines, boats, or planes.
Cultural Resources	♦ All activities would adhere to the cultural-resource protection procedures under CFR 800, Section 106. ♦ Potential impacts to cultural resources and appropriate mitigation would be addressed under a PA among the EPA, COE, Advisory Council on Historic Preservation, SHPO, and Teck-Pogo Inc.
Safety	♦ Enforcement of speed limits on Shaw Creek Road for Pogo project-related vehicles. ♦ All-season road limited to seven percent grades. ♦ All site roads with berms to conform to MSHA requirements. ♦ Explosives stored underground with locked storage magazines for caps, detonating cord, primers, and boosters.

4.21 Effects of Short-Term Uses on Long-Term Productivity

Section 102 of NEPA requires that an EIS include "the environmental impacts of alternatives including…the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity." Under all alternatives, the Pogo Mine site would be restored to pre-mining conditions and productivity. Surface water hydrology and aquatic habitat, as well as wildlife habitat, would generally be re-established after closure. Revegetation would occur throughout the mine site and should eventually approximate pre-mining conditions. Under all alternatives there would be some permanent wetlands loss. Reclaimed wetlands should provide similar functions and values as those lost. Overall, the reclamation of the site would create a somewhat wider diversity of habitat types (wetland and upland) than currently present.

If the access corridor also were reclaimed for all alternatives, similar revegetated conditions and a return of some reclaimed wetlands to similar functions would occur. If the access corridor were not reclaimed, loss of long-term vegetative, wetland, and wildlife habitat productivity would occur. Continued use of the corridor could result in additional mining or other resource developments that could affect long-term productivity if they were not reclaimed.

4.22 Irreversible & Irretrievable Commitments of Resources

An **Irreversible** commitment of resources is defined as the loss of future options. It applies primarily to nonrenewable resources, such as minerals or cultural resources, and to those factors that are renewable only over long time spans, such as soil productivity.

An **Irretrievable** commitment applies to loss of renewable resources and to a situation in which a resource can be irretrievable (temporarily) lost, but the action is not irreversible. For example, some or all timber production from an area would irretrievably lost while an area served as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use were to change, it would be possible to resume timber production.

Table 4.22-1 summarizes the irreversible and irretrievable impacts for all alternatives.

Table 4.22-1 Commitment of Resources

Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3	Alternative 4
Geology			
Minor irreversible and irretrievable impacts due to development rock and ore removed during exploration activity.	Irreversible and irretrievable commitments by mining approximately 11 million tons of ore and 2.3 million tons of development rock. The precious metals would be committed to the market. The resultant surface tailings and most development rock would have no use in the foreseeable future.	Same as Alternative 2	Same as Alternative 2
Surface Water Hydrology			
No foreseeable or predicted irreversible or irretrievable impacts.	The project would be required to comply with all applicable state and federal water quality regulations. Upper Liese Creek drainage pattern would be permanently altered. No other foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Groundwater Hydrology			
No foreseeable or predicted irreversible or irretrievable impacts.	The project would be required to comply with all applicable state and federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Water Quality			
No foreseeable or predicted irreversible or irretrievable impacts.	The project would be required to comply with all applicable state and federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Air Quality			
No foreseeable or predicted irreversible or irretrievable impacts.	Project would comply with the Alaska State Implementation Plan and ADEC air quality regulations. No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Noise			
Noise sources currently on site would be removed during reclamation, and there would be no foreseeable or predicted irreversible or irretrievable impacts.	No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Soils, Vegetation, and Wetlands			
The current approximately 30 acres of total	Irretrievable commitment of approximately 1,745[1]	Irretrievable	Irretrievable

Table 4.22-1 Commitment of Resources

Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3	Alternative 4
disturbance in the mine area (~26 acres of wetlands) have minor irretrievable commitments of vegetation and wetlands productivity.	acres of soil productivity, of which ~449 acres would be undisturbed wetlands.	commitment of approximately 1,690[1] acres of soil productivity, of which ~365 acres would be undisturbed wetlands.	commitment of approximately 947[1] acres of soil productivity, of which ~324 acres would be undisturbed wetlands.
Fish and Aquatic Resources			
No foreseeable or predicted irreversible or irretrievable impacts.	The project would be required to comply with all Alaska Statutes Title 16 regulations. Upper Liese Creek aquatic habitat would be permanently lost. No other foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 2	Same as Alternative 2
Wildlife			
Irretrievable short-term habitat loss on existing 30 acres of disturbance in the mine area.	Irretrievable short- and long-term habitat loss would occur on 1,745[1] acres.	Irretrievable short and long-term habitat loss would occur on approximately 1,690[1] acres.	Irretrievable short and long-term habitat loss would occur on 947[1] acres .
Socioeconomic Resources			
No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Land Use			
The wildland character of the exploration area would be restored through reclamation.	The wildland character of the mine area and access corridor would be irretrievably altered during mine construction and operation. This condition would be restored to the mine area following its reclamation, and to the airstrip and access corridor if they were reclaimed. If the road and airstrip were not reclaimed, the wildland character of the access corridor and airstrip area would be irretrievably lost.	Same as Alternative 2	Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected.
Subsistence			
No predicted irreversible or irretrievable impacts.	If the all-season road were open only to Pogo-related vehicles, there would be few subsistence resources irretrievably lost. If the road were open to use by other	Same as Alternative 2	Winter-only access would cause few

Table 4.22-1 Commitment of Resources

Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3	Alternative 4
	than Pogo-related traffic, there would be some irretrievable loss of subsistence use for duration of mine operations. If the road were to remain open to such use after mine closure, this irretrievable loss would continue and likely increase in severity. There would be no irreversible loss of subsistence resources.		irretrievable impacts.
Cultural Resources			
No foreseeable or predicted irreversible or irretrievable impacts.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Visual Resources			
Minor irretrievable commitments due to exploration disturbance.	Irretrievable and irreversible commitments would occur in the form, line, color, and texture contrast of the dry tailings pile in upper Liese Creek. Irretrievable commitments would occur from borrow areas, roads, power line, and structures during project construction and operation. Reclamation and natural succession of vegetation are expected to eventually mitigate most long-term visual impacts. Long-term irreversible commitments would occur if the road and airstrip were not reclaimed.	Same as Alternative 2	Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected.
Recreation			
No foreseeable or predicted irreversible or irretrievable impacts.	Irretrievable commitments of semi-primitive and primitive recreation opportunities would occur during construction and operation. These opportunities would be restored to the mine area following its reclamation, and to the airstrip and access corridor if they were reclaimed. If the road and airstrip were not reclaimed, these opportunities would be irretrievably lost.	Same as Alternative 2	Same as Alternative 2, except approximately 15-mile shorter access corridor would be affected.

[1] Entire alternative minus existing disturbance

Chapter 5 Agency Determination of Preferred Alternative

This chapter builds on the impacts analysis of the individual options and alternatives in Chapter 4. Section 5.1 summarizes the impacts described in Chapter 4 in tabular form. Section 5.2 then describes how those impacts were analyzed to identify EPA's and the cooperating agencies' Environmentally Preferable Alternative and their Preferred Alternative. Finally, Section 5.3 presents the Environmentally Preferable Alternative and the Preferred Alternative in both tabular and graphic formats.

5.1 Impacts Summary

The impacts of the four alternatives are summarized below in tabular form that generally follows the presentation format of Chapter 4. Table 5.1-1 summarizes the impacts of the No Action Alternative and those options that are common to all alternatives. Thus, if the project were not to proceed to development, the impacts in column 1 of Table 5.1-1 would occur. If the project were to proceed to development, the impacts in column 2 would occur, regardless of which alternative were selected.

Table 5.1-2 summarizes the impacts of options that are specific to one of the three action alternatives, but that are not access related. Table 5.1-3 summarizes options that are specific to one of the three action alternatives, and that are access related. The descriptions of impacts assume the recommended mitigation measures would be implemented. Note that as a convention, if a particular option would have no, or only a small, impact on a given resource, it generally is not discussed.

A more detailed analysis of the impacts on each resource was presented in the individual sections of Chapter 4. These tables do not include cumulative impacts, which also are discussed in more detail in the individual sections of Chapter 4. Cumulative impacts were summarized separately in Table 4.19-1.

The reader is urged to refer frequently to Tables 2.5-1, 2.5-2, 2.5-3, and Figure 4.0-1, to understand which options constitute a particular alternative.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.1 Surface Water Hydrology	
Small impacts on the surface water hydrology of Shaw Creek and its tributaries would occur from Division of Forestry (DOF) road construction and logging. After closure of the existing Pogo exploration adit, impacts on the Goodpaster River in the Pogo claim area would be low.	General mine area. Placement of the dry stack, RTP, mill facilities, and associated water-diversion ditches would result in substantial modification of the surface water hydrology in Liese Creek. These impacts would be localized to Liese Creek, with very small impacts to the Goodpaster River. Impacts on surface water hydrology from other common options would be low.
4.2 Groundwater Hydrology	
No impacts are expected from DOF road construction and logging. After closure of the existing Pogo exploration adit, impacts on ground water in mine area would be low.	General mine area. Dewatering of the mine would have moderate impacts on the groundwater hydrology in the vicinity of the mine and Liese Creek Valley. Installation of an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact the quantity of seepage from the dry stack that would enter the ground water. The overall impacts on groundwater flow in the Goodpaster River Valley would be very low. Impacts on groundwater hydrology from other proposed project components would be low.
4.3 Water Quality	
There would be a potential for fuel spills during DOF road construction and logging, and subsequent impacts on water quality for Shaw Creek and its tributaries. Impacts would be low if proper safeguards were used. Potential for erosion and release of sediments to Shaw Creek and tributaries would be low if proper forestry BMPs were used.	General mine area. Impacts on Liese Creek below the RTP would be low during operations. Installation of an erosion control/drainage blanket prior to constructing the dry stack is not expected to impact either the quantity or quality of the seepage from the dry stack. Following closure, the RTP would be drained and capped with fill overlain with rock as a mitigation measure to protect sediments from erosion. This would reduce potential impacts to a low level. After mine closure, seepage of ground water from the mine would transport dissolved constituents to the slope and valley alluvium. Moderate increases in concentrations could occur for some parameters over the long term of 100 to thousands of years. These impacts would be localized between the mine and the river. Minimal impacts are expected on Goodpaster River water quality. During operations, moderate impacts would occur to water quality in Liese Creek between the tailings dry stack and the RTP from runoff and seepage from the dry stack and mineralized development rock. After closure of the dry stack, water quality would improve. Domestic wastewater would be treated with a single ADEC-approved package sewage treatment plant, and then would be discharged directly to the Goodpaster River. A mixing zone would be required in the river, but it is expected that the discharge would result in low to very low impacts. Air access. Without mitigation, use of the airstrip could result in a large spill that could have a high impact on water quality. With use of planned secondary containment and additional BMPs, the likelihood and severity of spills would be reduced and the overall impact would be low. Use of the airstrip only by the Pogo project would have the smallest potential to affect water quality. The potential for impacts to water quality would increase with more users. At the end of the Pogo Mine life, removing and reclaiming the airstrip would have the least impact and keeping it open for all users would have the highest potential for impacts on water quality due to fuel spills.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.4 Air Quality	
There would be no major air quality impacts.	General mine area. Construction would cause short-term, localized impacts on soils, vegetation, and visibility in the immediate mine area as a result of fugitive dust. Construction and mine operation equipment and generators would release combustion products locally. These impacts would be low and inconsequential.
4.5 Noise	
No changes of consequence in project area noise levels were projected. Dominant noise sources would continue to include local fixed-wing aircraft and helicopter overflights, existing mining and exploration operations, snow machines and ATVs, USAF aircraft overflights, and heavy truck traffic on the Richardson Highway.	General mine area. Because the distances to noise sensitive receivers in the lower Goodpaster River, Shaw Creek Road, Quartz Lake, Big Delta, and Delta Junction areas would be in excess of 15 miles, initial mine area blasting noise was projected to have no impact in these areas. Once blasting moved underground, there would be no surface impacts. Mine area operational noise would not be audible at sensitive receivers in these areas even under extreme conditions. During initial construction, noise levels on the Goodpaster River between Pogo and Liese creeks were projected to range from 30 to 40 decibels A-weighted (dBA). Mine operational noise levels in this same area were projected to range from 25 to 35 dBA. Because this area is primarily used for recreation, with outboard motors in the summer and snow machines in the winter, noise impacts would be low.
4.6 Wetlands	
Overall wetlands impacts would be minimal. The DOF's proposed timber harvests generally would not include substantial wetland areas, but access roads to the timber likely would. Roads would be built in the Quartz Lake area and along the Shaw Creek Hillside. Both these forestry roads would entail loss of wetlands along an estimated 10 to 20 percent of their lengths. These roads would open up new areas for use by ATVs, which tend to use and damage wetlands.	General mine area. Alternative 3 would require filling 1 more acre of wetland than Alternative 2 at the airstrip. Alternative 4 would require clearing 6 fewer acres of wetlands than Alternative 2 or 3 because a power line would not be built at the mine. Alternative 4 would require filling 12 to 13 more acres of wetlands than Alternative 2 or 3 because of increased storage space needed for a years' fuel and other supplies. Mill, camp, and tailings disposal impacts would be high only in the context of Liese Creek Valley. Impacts of facilities on the Goodpaster Valley floor also would be locally high, with gravel pits providing some wetland benefits if they were to become ponds.

	Alternative		
	2	3	4
Cut/fill (acres)	152	153	165
Clear only (acres)	14	14	8

No Action Alternative	Options Common to All Alternatives
4.7 Surface Disturbance	
Approximately 33 acres of surface disturbance presently exist in the mine area. These areas would be reclaimed and revegetated. DOF's eight planned timber sales would disturb approximately 1,313 acres, not including new timber access roads.	General mine area. Approximately 383 acres of disturbance would occur. There would be no substantive differences in disturbance between the alternatives, except for the gravel source option. If gravel were made from crushed mine development rock, as opposed to being mined from gravel pits, 72 fewer acres would be disturbed, leaving a total of approximately 311 acres of disturbance.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.8 Fish and Aquatic Habitat	
Impacts would be none to low if DOF road construction and logging were conducted with appropriate BMPs.	Air access. Impacts would be low to nonexistent, provided that suggested mitigation measures were implemented. If the airstrip were open to all users, impacts would increase to low to moderate.
4.9 Wildlife	
Impacts generally would be low; they would be high only on a very local basis. Timber harvesting using BMPs could provide some medium- and long-term habitat benefits to species such as moose.	General mine area. Direct habitat loss would be high only on a local mine site basis. Direct impacts on birds and mammals would be high only on a local mine site basis. There would be no high indirect impacts to birds. Moose, brown bears, and marten could experience indirect impacts, but these would be high only on a local mine site basis. There would be minor disruption of large mammal movements because of mine site facilities. Occasional entrapment in the RTP also is a possibility. If garbage were not handled properly, bears likely would have to be killed. Gravel source. Mining gravel, rather than crushing development rock, would cause surface disturbance to an additional approximately 66 acres on the Goodpaster Valley floor. Disturbance generally would be to lower value habitat. And, if the gravel pits were reclaimed as ponds, habitat benefits would accrue. Still, mining gravel would have a moderate local overall habitat impact compared to crushing development rock for gravel. Air access. Removal of the airstrip at mine closure would allow the relatively high-value habitat to begin recovery, and would eliminate continuing indirect habitat impacts from human activities.
4.10 Threatened and Endangered Species	
There would be no impacts on threatened or endangered species, and impacts to sensitive species would be low.	There would be no impacts on threatened or endangered species. Impacts to sensitive species would be high only on a local basis.
4.11 Socioeconomics	
The NMDS would increase employment from ~750 to ~900 jobs by perhaps 2005 or 2006, and Delta area population could stabilize then at approximately 2,100. Existing housing could be tight during NMDS construction, but should be sufficient for operation. The local economy would continue to be based on the military and tourism. Other basic economic activity, including mining, transportation, regional health care, state government, and federal government, would continue to play a role in the local economy. A natural gas pipeline would have only a short-term effect on the area.	Air access. Only airstrip operation and disposition could affect Delta area socioeconomic conditions. If the airstrip were open to other industrial/commercial users or to everyone, it could provide some additional industrial/commercial development and create some new economic activity, population growth, and demand for public services. Removal and reclamation would eliminate this potential.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.12 Land Use	
Land use changes would occur consistent with current Delta area economic development trends, construction of the NMDS, and possible construction of a natural gas pipeline. New residential, commercial, and industrial activities (housing, lodges, stores, and quarries) would occur in the existing developed Delta area at a level consistent with ongoing needs or other actions in the area. DOF's eight planned timber sales would disturb approximately 1,313 acres in the lower Shaw Creek, Quartz Lake, and Indian Creek areas, not including new timber access roads.	Air access. Closing the airstrip to everyone but the Pogo project could have a major negative effect on potential new commercial and industrial activities, such as mining. Allowing other commercial/industrial users to access the airstrip could provide new service support options for commercial and industrial activities, as well as fly-in recreationists. Removing and reclaiming the airstrip could have a major impact on commercial air operators, recreationists, and potential new mineral development in the area.
4.13 Subsistence	
There would be no or low effects on the availability of subsistence resources. Except for local areas accessed by the DOF planned timber harvest roads in the Shaw Creek Valley and the vicinity of Quartz Lake and Indian Creek, there also would be no or low effects on access to or competition for subsistence resources. In those local areas accessed by the DOF timber harvest roads, there would be moderate effects to access (new transportation corridor) and competition (road users) for important subsistence resources (moose, caribou, waterfowl, and upland birds). These effects on access and competition, however, would be spread out over time because the roads likely would be constructed incrementally.	General mine area. Impacts would be low, except in the immediate mine area where subsistence users would be prohibited from hunting for public safety purposes. This area, however, is small within the context of the overall subsistence use areas for caribou, moose, and upland birds. Competition in the general mine area would not be affected because of the Applicant's no hunting and fishing policy for employees. Recent Upper Tanana Athabaskan caribou and moose subsistence use areas are substantially larger than the footprint of the mine site, and the lack of availability of the mine site for subsistence hunting would not affect the overall pattern of subsistence use because other areas are available for harvesting these species. And, there would not necessarily be any increased effort, cost, and/or risks if subsistence hunters were unable to hunt at the mine site because this location is not a readily accessible area from any community. Inability to hunt at the mine site would be more of a noticeable reduction in opportunity to hunt in a traditional place that was used by one's relatives and ancestors. Thus, it could be construed as a loss of a part of one's homeland for hunting, but not the primary or most used hunting area. Fuel storage. Temporary fuel storage below the 1525 Portal and at the airstrip would not be within the recent subsistence use area for fish; however, recent subsistence fishing areas are located downstream. If contamination from this facility were to cause fish damage, decline, displacement, or contamination, it would affect availability to subsistence fishers. Also, just concerns about contamination could lead to reduced fish consumption because of fear of contaminated resources. Depending on duration and severity, it could have a moderate effect on subsistence fishing uses. While there are substantial other areas available for subsistence fishing and the overall pattern of subsistence uses would not be seriously jeopardized in such an event, the Goodpaster River is a currently used and highly regarded river by descendents and related kin of Athabaskans who used this area traditionally. Air access. For availability, access, and competition criteria, the most restrictive airstrip use and disposition options (airstrip open only to Pogo project use during mine operations and removal and reclamation at the end of mine operations) would have low effects. Conversely, the least restrictive options (airstrip open to everyone during and after mine operations) would have moderate to high subsistence effects.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.14 Cultural Resources	
Larger developments would be subject to Section 106 review and mitigation stipulations by the SHPO before construction; therefore, impacts would be few. Private land development is not subject to Section 106 review. Gradual increases in land sales, homes, and recreational uses could result in damage to cultural resources as sites were developed. More recreational use would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage.	General mine area. Because adherence to cultural-resource protection procedures under CFR 800, Section 106, are the accepted process by which to mitigate impacts to cultural resources, no high impacts to cultural resources are expected from development of these options.
4.15 Visual	
Areas cleared for installation of the NMDS, as well as clearing for related residential, commercial, and industrial land sales and development, would cause long-term impacts on visual resources. Planned timber harvests would change visual quality and scenic integrity, and impacts to backcountry, recreational, and airborne viewers could be high.	Tailings dry stack. Because of the area's low visual absorption capability (VAC) due to slope and topography, distance and duration of the viewpoints would determine the importance of visual impacts of the above ground tailings dry stack. Airborne view impacts would be high. The dry stack likely would be relatively well screened by vegetation from viewers on the Goodpaster River, and impacts would be low. Mill and camp. Goodpaster River recreationists would have obscured foreground and middle-ground views of the mill and camp development and the visual impacts would be low. Airborne viewers would have obscured views of the mill and camp development due to the valley's slope and topography, but impacts could be somewhat higher to airborne viewers desiring a totally primitive experience. Air access. Airstrip use and disposition would have impacts to visual resources and scenic integrity. Backcountry users desiring a nonmotorized experience would see greater aircraft activity, as well as more recreational users, if the airstrip were open to everyone during and after mine operations.
4.16 Recreation	
There would be no major changes to recreational use, except those from the DOF road that would open areas in the Shaw Creek drainage to recreational users. The opening of these areas would have a high impact on existing recreational users in the vicinity of the forestry road, but would be a substantial benefit to prospective recreational users.	Air access. If the airstrip were open to everyone during mine operation, and were to remain open after mine closure, it would be a major benefit to prospective recreational users, particularly to those desiring to hunt, fish, or float the Goodpaster River. This air access would have a low effect on existing recreational users of the mine area because there is presently little recreational use. Recreational cabin owners on the lower Goodpaster River, however, could be affected moderately by floaters and fishers who would float into the lower river past these cabins. This river use would alter the present isolation of the cabins and could cause changes in fishing bag and size limits, as well as an increase in littering and vandalism.

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
4.17 Safety	
Impacts would be low.	Impacts would be low.
4.18 Technical and Economic Feasibility	
The No Action Alternative is not applicable for the technical and economic feasibility criteria.	Mining gravel versus crushing development rock. Gravel is on the critical path for project construction. It would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option. Most of the nonmineralized rock that would be generated from underground would not be available until later in the two-year project development period. Underground mine development must follow completion of the appropriate surface facilities described above. Advancing underground development before beginning the surface civil works isn't possible because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable. From another perspective, experience during the Pogo Mine exploration phase has demonstrated that underground development rock does not make a good traffic surface for high volume roads. At the existing advanced exploration facilities, gravel has been used to top the surface of the high volume roads because the development rock breaks down under traffic loads and becomes mud. Thus, from a technical perspective, crushing development rock to make gravel would not be feasible or practicable. Also, a gravel road topping has helped to reduce sedimentation both on the surface and underground, where reduced sedimentation in the mine sumps has been an important factor in water treatment plant efficiency. Another need for gravel may arise for topping portions of the mine access road. Test work at potential material sites along the proposed Shaw Creek Hillside road alignment has shown the rock in most of the proposed material sites does not conform to ATM T-13 degradation, or to Los Angeles Abrasion ASTM C131-96 specification for coarse abrasion testing of coarse rock. Thus, while the rock from these sites would still be suitable for bulk fill, topping material with sufficient hardness for the road surface would have to be hauled long distances from select material sites. Two of the material sites may contain rock suitable for crushing and use for road topping, and it would be advantageous in some areas for the Applicant to do so rather than haul gravel from the vicinity of the mine. Some of the gravel from the mine area sites, however, could be used for access road topping. Even if nonmineralized development rock were suitable for crushing, which it is not, the direct cost to produce approximately 140,000 cu yd of aggregate for use in the mine area would be approximately three to four times greater than mining pit run gravel by expanding existing borrow pits and developing new ones as proposed by the Applicant. A reasonable cost estimate for pit run gravel at the Pogo site is approximately \$4 per cu yd. Thus, crushed development rock would cost between approximately \$1.1 million and \$1.7 million more than mined gravel (Rowley, 2002a). Mining gravel from existing and new pits versus crushing nonmineralized development rock for gravel would

Table 5.1-1 Summary of Direct and Indirect Effects of the No Action Alternative and Options Common to All Alternatives

No Action Alternative	Options Common to All Alternatives
	disturb approximately 66 more acres. As discussed later, the off-river treatment works was selected as the preferred option for the industrial wastewater discharge component. Because this option would require excavation of approximately 13.1 acres of gravel to create the two ponds, a portion of the overall project's required mine area gravel needs would be met during excavation of the ponds, and the 66-acre total would be reduced to approximately 53 acres. A portion of this disturbance would be to wetlands, and would have moderate impacts. But those impacts would be offset by pond creation in the gravel pits, resulting in negligible overall wetlands impact. Mining gravel would have a moderate local wildlife habitat impact although this, too, would be mitigated somewhat by pond formation. Still, surface mining of gravel would account for approximately 7 percent of the total surface disturbance for the Applicant's Proposed Project.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
4.1 Surface Water Hydrology		
Unlined tailings facilities. No effect on surface hydrology. Wastewater discharge. Injection of excess water into wells could raise water levels in adjacent sloughs by 2 ft. Overall impacts are expected to be low.	Wastewater discharge. Direct discharge of excess water to the Goodpaster River would increase flow in the river. Managing discharge flows to a ratio of 45:1 (river: discharge) would limit flow increase to approximately 2 percent. This managed discharge would have a low impact.	Wastewater discharge. Discharge via an off-river treatment works would reduce flow in an 1800-ft stretch of the Goodpaster, but a flow of at least 20 cfs would be maintained at all times in this stretch. Even during normal annual winter low flow conditions in the river, there would be enough water to meet wastewater mixing discharge requirements. Downstream of re-entry channel impacts would be the same as for Alternative 2.
4.2 Groundwater Hydrology		
Unlined tailings facilities. Low effect on groundwater hydrology. Wastewater discharge. Injection of excess water into wells or the soil absorption system (SAS) could raise groundwater elevations locally by up to several feet. Overall impacts are expected to be low.	There would be no groundwater impacts.	Same as Alternative 3.
4.3 Water Quality		
Unlined tailings facilities. Low effect on water quality. Wastewater discharge. Projected quality of the water to be discharged from the SAS during operations would not meet discharge criteria for a number of parameters. The inability to meet discharge criteria was considered as having a high impact from a permitting and compliance perspective, and may not be permittable.	Wastewater discharge. Direct discharge to the Goodpaster River with a mixing zone during development and operations would result in low impacts on water quality. The discharge is expected to meet all criteria for all parameters. It is uncertain, however, whether mercury would bioaccumulate to high adverse levels from this discharge; hence, it is uncertain whether a mixing zone could be granted.	On-site power generation. The need to transport approximately 4.2 million gallons of fuel to the mine site annually would result in a moderate to high potential to impact water quality. A major spill could cause a high impact over a large watershed area Wastewater discharge. Discharge to the Goodpaster River via an off-river treatment works during operations would result in low impacts to water quality. The discharge is expected to meet all criteria for all parameters. At 400 gpm residence time would be approximately 24 hours, which would provide ample time to respond to potential upset conditions at the water treatment plant.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

	Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
4.4 Air Quality	Power line. Low impact in the vicinity of the power generation source near Fairbanks that is operating under an existing air quality permit.	Power line. Same as Alternative 2.	On-site power generation. Would have low impacts on local air quality under permit conditions.
4.5 Noise	There would be no or low impacts.	Same as Alternative 2.	On-site power generation. Generators would use noise reducing equipment to meet OSHA standards, and would not cause a major addition to the noise levels projected for options common to all alternatives (Table 5.1-1).
4.6 Wetlands	Power line. Would require clearing and slightly disturbing ground surface of approximately 119 or 158 acres of wetlands and other water bodies, depending on route. Wastewater discharge. Minor SAS impacts at either the airstrip or above Pogo Ridge, but the latter would have greater wetlands acreage impacts. Injection wells. Could have the capacity to increase the groundwater table level, flood swales and otherwise dry sloughs, and create small, scattered, wetland-like areas. There areas likely would be sporadic, and ephemeral, and wetland benefits would be small.	Power line. Same as Alternative 2. Wastewater discharge. No or low impacts from direct discharge to Goodpaster River.	On-site power generation. The need to transport and store ~4.2 million gallons. of diesel fuel annually would substantially increase the risk of spills into wetlands. Also more road traffic would result in increase in dust and sediment-laden road runoff into wetlands. Impact would be minor because of low risk of a substantial spill. Wastewater discharge. Off-river treatment works would have no additional wetland effects beyond those for the gravel pits because it would be constructed in the excavated pits.
4.7 Surface Disturbance	Power line. 602 or 525 acres of clearing, depending on route. Wastewater discharge. 4.4 acres for the SAS.	Power line. Same as Alternative 2. Wastewater discharge. 0.5 acre for direct discharge to Goodpaster River.	On-site power generation. ~22.7 acres for extra fuel storage (6.1 acres) and laydown area (16.6 acres) to accommodate winter-only access need to store a full year's fuel and supplies. Wastewater discharge. 13.1 acres, but would be constructed in already excavated gravel pits.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
4.8 Fish and Aquatic Habitat		
SAS. Depending on where the ground water would reach the river, overall impacts to the river's aquatic resources in the long term would be low to moderate, and would be localized.	Direct discharge to Goodpaster. This option would have a high impact on aquatic resources in the immediate vicinity of the diffuser pipe and a low impact outside the mixing zone during normal operations. Process upsets and facility failure could cause impacts. Because the probable frequency of these events is low, and the dilution factor is high, the impacts would be moderate and localized.	On-site power generation. This option would substantially increase risk of accidents during fuel transport and storage that could have moderate to high local impacts, and high impacts to the chinook population if an accident occurred during low winter flows or spawning. Off-river treatment works. This option would have fewer impacts than the other discharge options. Process failures, mine shutdowns, and environmental upsets could be better addressed with this option, considering its storage capability. Because of the low probability of the combination of upset events that would exceed the storage capability and the unknown effects of severe winter weather on the process facilities, impacts would be low to moderate and localized. A minimum flow of 20 cfs would be maintained in the Goodpaster River at all times to provide sufficient flow for fish.
4.9 Wildlife		
Power line. Would require clearing vegetation on approximately 602 or 525 acres, depending on the route. Clearing generally would not destroy vegetative mat. Altered habitat would still provide support to wildlife, although of a different species composition. Habitat impacts, and indirect impacts to birds and mammals, would be high only on a local basis. Birds would experience direct impacts from collisions, but these are expected to be high only on a local basis. Browsing mammals would benefit from the edge effect created by clearing the ROW. This benefit would be of importance only on a local basis. SAS and underground injection. SAS surface disturbance to 4.4 acres would be moderate only on local basis.	Power line. Same as Alternative 2. Direct discharge to Goodpaster. Low impact.	On-site power generation. This option would require an additional ~22.7 acres of surface disturbance for increased diesel fuel storage and laydown area versus clearing vegetation on approximately 602 or 525 acres for a power line, depending on the route. Loss of ~22.7 acres would be moderate and only on a local basis. This option would require ~4.2 million gallons of fuel to be transported to the mine site annually. The transportation of fuel would pose a greater impact risk to wildlife and habitat from spills than would the power line option clearing. There would be only very local high direct or indirect impacts to birds or mammals from this option.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
		Water discharge. Off-river treatment works would have few additional effects beyond those for the gravel pits because it would be constructed in the excavated pits.
4.10 Threatened and Endangered Species		
Power line. There would be no impacts on threatened or endangered species. For sensitive species, ROW clearing could cause loss of some raptor nest sites, depending on the route. Because portions of both routes would traverse forested habitats, there would be a collision risk for Northern Goshawks.	Power line. Same as Alternative 2.	On-site power generation. There would be no impacts on threatened or endangered species. There would be no power line ROW clearing impacts. Risks from fuel spills from substantial additional fuel transport would be the same as discussed above for wildlife.
4.11 Socioeconomics		
Power line. Greater long-term potential for supporting additional industrial/commercial activity, allowing mine developers or others to enjoy a substantial construction and operation cost savings compared to constructing a new power line or providing on-site generating capacity.	Power line. Same as Alternative 2.	On-site power generation. This option would not provide the greater long-term potential for supporting additional industrial/commercial activities that a power line would.
4.12 Land Use		
Power line. Would benefit potential new commercial and industrial land uses.	Power line. Same as Alternative 2.	On-site power generation. This option could have a high impact on potential commercial and industrial users because mineral development could be slower without a power line to Pogo. Such development would need to haul fuel for on-site generation, or construct a power line.
4.13 Subsistence		
Power line. ROW clearing would create an access corridor for recreational as well as subsistence users, and could increase competition for subsistence resources. Mitigation measures could limit ROW access to some extent. If road use were open to everyone, however, the power line ROW would offer little advantage because it would closely follow the road alignment.	Power line. Same as Alternative 2. Direct discharge to Goodpaster. If this option were to cause impacts on fish and aquatic habitat from process upsets, facility failures, or bioaccumulation, it could lead to the same impacts on subsistence fisheries downstream as described for fuel storage in Table 5.1-1 (Options Common to all Alternatives).	On-site power generation. This option would require greater on-site fuel storage and surface movement of approximately 4.2 million gallons of fuel annually. Storage and movement of fuel would substantially increase the risk of fuel spills at stream crossings and from transfers between tankers and storage tanks, raising the same concerns for downstream impacts to fish, fish habitat, and subsistence fisheries as described in Table 5.1-1 (Options Common to all Alternatives). Off-river treatment works. Same as Alternative 3.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
		This option would have the capacity to provide u to 24 hours of holding time in case of upset conditions at the water treatment plant.
4.14 Cultural Resources		
Because adherence to cultural-resource protection procedures under CFR 800, Section 106, are the accepted process by which to mitigate impacts to cultural resources, no major impacts to cultural resources are expected.	Same as Alternative 2.	Same as Alternative 2.
4.15 Visual		
Power line. High visual impacts because of the scale, distance, and viewer recognition of power poles compared to on-site power generation.	Power line. Same as Alternative 2.	On-site power generation. This option would require additional 22.7 acres for fuel storage and laydown area at the airstrip. This use of additional acreage would have a low impact on views of recreationists on the Goodpaster River. Impacts would be very substantially less than for a power line.
4.16 Recreation		
Power line. Without mitigation, the cleared power line ROW would provide a benefit of backcountry access for new motorized and nonmotorized recreational users, depending to what extent mitigation measures were implemented to limit access. This increased access, however, would have a high impact on existing recreational users. If road use were open to everyone, however, power line ROW clearing would offer little advantage because it closely follows road alignment.	Power line. Same as Alternative 2.	On-site power generation. This option would cause a small increase in noise and other activity in the vicinity of the mine and access route due to the generators and the additional fuel transportation. This disturbance would have a low to moderate impact on primitive and semi-primitive motorized Recreation Opportunity Spectrum (ROS) classes.
4.17 Safety		
Impacts would be low.	Same as Alternative 2.	Same as Alternative 2.
4.18 Technical and Economic Feasibility		
Tailings dry-stack liner. Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability	Same as Alternative 2.	Same as Alternative 2.

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
perspective, however, a liner would be more problematic. The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk. Overall, there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner. Installation of an erosion control/drainage blanket before tailings would be placed in the dry-stack tailings facility was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation. <u>RTP liner</u>. The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities. Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cut-off wall. The proposed RTP dam face liner system and grout curtain would establish an effective interception cut-off wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled		

Table 5.1-2 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Not Related to Surface Access

Alternative 2 (Power Line and SAS/Injection Wells)	**Alternative 3** (Power Line and Direct Discharge to Goodpaster River)	**Alternative 4** (On-Site Power and Off-River Treatment Works)
curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock. ▪ A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including: ▪ A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cut-off wall required to collect the subsurface seepage. If such a cut-off wall at the upgradient end of the liner were required, it would follow that another liner upstream of that cut-off wall also would be needed, etc. It is thus a cut-off wall perpendicular to the flow that would be needed to capture seepage, not a liner. ▪ Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume. The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V). A full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage. From the economic perspective, if a liner were feasible, a very rough estimate for the cost of a full basin liner under the RPT is approximately $1.5 million.		

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
4.1 Surface Water Hydrology		
Shaw Creek Hillside all-season road. During and immediately following construction, modifications to surface water hydrology could occur due to increased runoff volumes caused by vegetation removal and soil compaction. Increased flows could be mitigated by using storm water runoff BMPs. Most of the road is at least 1 mile from Shaw Creek, and no surface water hydrologic impacts would occur directly to the creek.	South Ridge all-season road. Six fewer bridges and fewer other stream crossings than for Alternative 2 would be required. Because route would be along the divide between the Shaw Creek and Goodpaster River drainages, the potential for surface water hydrologic impacts, regardless of how minor, might impinge on two watersheds, rather than one. A mitigating condition would be that the separation distance to substantial discrete streams from the road appears to be a half-mile or more.	Winter-only access. Same as Alternative 2, except for the tendency of ice roads to thaw later than surrounding areas, raising potential for blockage or rerouting of runoff flows during breakup. These effects would be localized and temporary.
4.2 Groundwater Hydrology		
No groundwater flow impacts were identified.	Same as Alternative 2.	Same as Alternative 2.
4.3 Water Quality		
Shaw Creek Hillside all-season road. Primary potential impact to water quality would be from a fuel or chemical spill during transport to the mine site. The likelihood of a major release would be low, but the potential impact from a large spill into surface waters would be high. The overall water quality impact of fuel and commodity transport by this access route would be moderate. Road use and disposition. Use by the Pogo project only would have the lowest potential for accidents and subsequent releases. With increased usage, the potential for a release would increase. Continued use after mine closure would cause spill risks to persist.	South Ridge all-season road. The likelihood of a major spill would be moderate, because of the more exposed conditions, ice, higher winds, and greater potential for whiteout conditions in winter. But potential for an individual spill to affect a water body would be lower because of fewer wetlands and the road distance from active drainages. Overall water quality impact of commodity transport by this access route would be moderate. Road use and disposition. Same as Alternative 2.	Winter-only access. Because of the intense use of the road under difficult winter driving conditions, and the route's initial alignment through more wetlands, this option would have a high potential to affect water quality. Road use and disposition. Same as Alternative 2.
4.4 Air Quality		
Shaw Creek Hillside all-season road. There would be no or low impacts. Generation of fugitive dust from the all-season road would have a small effect on adjacent vegetation. Road use. Restricting use of the road during Pogo operation would limit fugitive dust proportionally. Road disposition. If maintained, restricting use would	South Ridge all-season road. Same as Alternative 2. Road use. Same as Alternative 2. Road disposition. Same as Alternative 2.	Winter-only access. Seasonal use of the winter-only access segment would eliminate fugitive dust impacts in lower Shaw Creek Valley, and would reduce them on the all-season road segment because it would be used only in winter.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	Alternative 3 (South Ridge Corridor)	Alternative 4 (Shaw Creek Flats Winter-only Access)
limit fugitive dust proportionally. If removed and reclaimed, it would eliminate low fugitive dust impacts.		
4.5 Noise		
Shaw Creek Hillside all-season road. No major impacts were identified. Shaw Creek Road egress. Pogo-related impacts to Shaw Creek Road area residences would be low or moderate, with one exception that would be moderate to high. If the Applicant's shift-change bus station were near the TAPS crossing, two residences would experience a moderate to high impact and four would experience a high impact. If the bus station were located on the Richardson Highway, one residences would experience a moderate impact, three a moderate to high impact, and one a high impact. Road use and disposition. Additional traffic noise from allowing everyone to use the road during and after Pogo operations would cause only a small increase in impacts above the Pogo-related level, but would approach a high impact for one residence. Of the disposal options, only removal and reclamation would reduce impacts in a meaningful way.	South Ridge all-season road. No major noise impacts on residents in the Quartz Lake and lower Goodpaster River areas were identified. Road use and disposition. Same as Alternative 2.	Winter-only access. There would be no major noise impacts.
4.6 Wetlands		
Road/power line surface disturbance. All-season road and power line would cut and fill ~120 acres and clear ~158 acres of wetlands, for a total of ~278 acres. Shaw Creek Hillside all-season road. Impacts would be high within each wetland complex through which the road passed, but would be dispersed along 49-mile route and focused on flat wetlands, which are the least valuable wetland type. Effects would be minor in the context of the Shaw Creek and Goodpaster drainages. Shaw Creek/Rosa egress. No impacts. Tenderfoot egress. No impacts. Road use. Use only by Pogo or other industrial or commercial users would cause minor impacts in the context of Shaw and Goodpaster drainages. Use by everyone, particularly unregulated ATVs, would cause moderate impacts.	Road/power line surface disturbance. All-season road and power line would cut and fill ~75 acres and clear ~119 acres of wetlands, for a total of ~194 acres. This acreage would be ~84 fewer acres than Alternatives 2, with ~45 of the acres with less cut and fill. South Ridge all-season road. Same as Alternative 2. Road use. Same as Alternative 2, except road use by everyone would cause only minor impacts because less off-road ATV use in wetlands is expected. Road disposition. Same as Alternative 2, except road use by everyone would cause only minor impacts because less	Road surface disturbance. The winter-only access segment and all-season road segment, with no power line, would cut and fill ~103 acres and clear ~50 acres of wetlands, for a total of ~153 acres. This affected acreage would be ~125 acres and ~41 fewer acres than Alternatives 2 and 3 (including their power lines), respectively. Road/power line surface disturbance. Although Alternative 4 by definition has on-site power generation, the winter-only access option could be paired with a power line as the Preferred Alternative. In that case, the road and power line combined would cut and fill ~135 acres and clear ~211 acres of wetlands, for a total of ~346 acres. This affected acreage would be ~68 and ~152 more acres than Alternatives 2 and 3 (including their power lines), respectively.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
Road disposition. Continued use only by industrial or commercial users would cause minor impacts. Use by everyone would cause high impacts in certain localities, but moderate impact within the context of Shaw and Goodpaster drainages. Security gate at Gilles Creek. Same impacts as use by everyone, but moderate impacts would be limited to the area west of Gilles Creek. Power line. Would affect extensive area by clearing, but effects would be only minor because most wetland functions would remain undisturbed or be affected to minor degree; disturbance would be primarily to lower value wetlands; and disturbed areas would be a minimal proportion of wetland resource in the project area. Sutton Creek. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the Shaw Creek / Goodpaster divide rather than up Sutton Creek. Wetlands disturbance in the Sutton Creek segment would total approximately 4 acs. Because the boundaries between wetlands and uplands are more distinct along this route, the power line likely could be sited to avoid some of these wetlands. Wetlands disturbance if the power line were routed adjacent to the road over the divide would total approximately 6 acres. Because the power line would traverse primarily mosaics of wetlands/uplands along this route, wetlands would be more difficult to avoid. While fewer wetlands would be affected by the Sutton Creek route, the absolute difference would be small, and following the road route over the divide would remove all wetlands impacts from the Sutton Creek drainage.	off-road ATV use in wetlands is expected. Power line. Same as Alternative 2.	Winter road/trail construction standards. Under the traditional winter road option, a higher percentage of wetlands would be cleared only down to the organic mat, and would remain wetlands and retain their functions. The perennial winter trail option, however, would cut or fill 24 more acres than the traditional winter road option because its construction method would cut the ground surface. Road use. By its seasonal nature, this alternative would be less likely to promote additional development and cause wetlands impacts in the Shaw Creek, Goodpaster, and adjacent drainages. Once the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek, however, impacts from road use would be the same as for Alternative 2.
4.7 Surface Disturbance		
Surface access. 770 acres for Shaw Creek Hillside route with Shaw Creek/Rosa egress option. 43 more acres with Tenderfoot egress option (total 813 acres). Power line. 602 acres for Shaw Creek Hillside route.	Surface access. 768 acres for South Ridge route. Power line. 525 acres for South Ridge route.	Surface access. 594 acres for Shaw Creek Flats winter-only access route. Power line. If a power line were paired with winter-only access, 600 acres would be cleared for the Shaw Creek Hillside route.
4.8 Fish and Aquatic Habitat		

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
Shaw Creek Hillside all-season road. Impacts would be none to low. Road use. Opening route to everyone would raise overall impacts to low to moderate, with increase in direct and indirect impacts due to traffic volume and recreational activities. Motorized boating in low flows on the Goodpaster River could disrupt spawning behavior and dislodge and suffocate eggs. Exhaust emissions pollute water and could disturb riparian habitat by undercutting banks through wake action. The number of boats on the Goodpaster would increase. Road disposition. Maintaining road open to everyone would have same impacts as for road us. Security gate at Gilles Creek. This sub-option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. This option would eliminate impacts from angling and boating on the Goodpaster.	South Ridge all-season road. Same as Alternative 2, except this route would have even fewer impacts because it would require only one stream crossing (Goodpaster River) and completely avoid the Shaw Creek drainage. Road use. Same as Alternative 2. Road disposition. Would differ from Alternative 2 because with no stream crossings other than the Goodpaster, the remove and reclaim option would still allow ATV access to the Goodpaster via cleared ROW for some time following reclamation. Such access likely would result in erosion problems, as shown by historical ATV use.	Winter-only access. Impacts would be higher than for Alternatives 2 and 3 due to risk of accidents during the short winter transportation window, especially fuel spills, at or near stream crossings under severe winter conditions, and particularly on the steep divide between Shaw Creek and Goodpaster drainages. An accident near the upper Shaw Creek or Goodpaster crossings could cause high impacts to overwintering fish during low flows of winter. Road use. This option initially would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2, unless public use was restricted.
4.9 Wildlife		
Shaw Creek Hillside all-season road and power line. Habitat. Because the approximately 1,372 combined acres of disturbance would be linear in nature; have low or no impacts on rarer or uncommon habitat classes; are well represented within the project area as well as interior Alaska; would affect few Conservation Priority Index lands; and would have small impacts on high-value habitat for large mammals, the bird and mammal habitat loss for Alternative 2 would not be high. Also, the approximately 602 acres within the power line ROW would only be cleared, with little actual surface disturbance. Birds. Primary direct impacts would be from collisions, and would be high only on a local basis. These impacts likely would be lower than for Alternative 3 because for most of its route in Shaw Creek Valley the power line would be within forest habitats rather than exposed above timberline. If daytime visual markers on the lines were not used for the crossing from Shaw Creek to the	South Ridge all-season road and power line. Habitat. Approximately 1,293 combined acres of disturbance would occur. Habitat impacts would be similar to Alternative 2, and would not be major. This alternative, however, would disturb roughly twice the acreage of high-value habitats for moose, caribou, and brown bear than would Alternative 2. Also, the approximately 525 acres within the power line ROW would only be cleared, with little actual surface disturbance Birds. Direct and indirect impacts on birds would be the same as Alternative 2, except that bird-power line collisions likely would be higher because for approximately 25 miles the power line would be above timberline along the	Winter-only access. Habitat. Approximately 594 acres of disturbance would occur. Habitat impacts would be similar to Alternative 2, and would not be high. This alternative, however, would disturb only approximately 37 acres of high value Conservation Priority Index lands in lower Shaw Creek Valley versus approximately 85 acres for Alternative 2. This alternative also would disturb approximately 54 percent less high value habitat than would Alternative 2. Birds. Direct and indirect impacts would be the same as for Alternative 2. Mammals. Direct impacts from collisions would be more likely to occur than for Alternative 2 because of substantially greater winter traffic, especially if deep snow were to accumulate and cause animals to use the road surface for movements. These impacts would be locally low to moderate, depending on the particular winter.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
Goodpaster River, bird collisions would be more likely to occur. There would be no major indirect impacts. Mammals. Primary direct impacts for both small and large mammals would be from vehicle collisions, particularly in winter when the cleared road would be favored for movements by larger animals. This mortality would not be high even on a local basis. If the road were open for use by everyone, this mortality could be high only on a local basis. Indirect impacts would be low for most species. Except for the intense road use period during construction, the road-related noise and activity should have only a small effect on moose in the Shaw Creek Valley rutting area. Brown bears and wolverines likely would avoid the road corridor other than for crossing. This road corridor avoidance would not cause major habitat fragmentation for these species. For marten, however, the road corridor likely would serve as more of an indirect behavioural barrier to movements and could cause some habitat fragmentation. Security gate at Gilles Creek. Impacts would be similar to those described above, except that public use would extend to only the lower two-thirds of Shaw Creek Valley. This reduction of public use would lower collision mortality. Power line route. The sub-option of following the road corridor over the Shaw Creek / Goodpaster divide, rather than separately up Sutton Creek, would have approximately the same habitat impact, but by consolidating the two corridors, as occurs for the large majority of the remainder of this alternative's route, it would remove all wildlife impacts from Sutton Creek with minimal additional impacts adjacent to the road.	South Ridge. Mammals. Indirect impacts generally would be the same as for Alternative 2. This alternative, however, would avoid the moose rutting area in Shaw Creek Valley, and its long run above timberline along the Shaw Creek and Goodpaster divide would not pose the same habitat fragmentation concern for marten as would Alternative 2.	Indirect impacts would be similar to Alternative 2, but would be very small for approximately 9 months of the year when surface access to the mine site would not occur. During the annual winter-only access construction and use period, however, vehicle noise and activity levels would be very high. The noise and activity would cause disturbance to moose and caribou, if they were in the vicinity, at a critical time (mid- and late winter) when energy reserves are low. Road use. This alternative effectively would eliminate road use impacts by the public; however, this condition would last only until the DOF road eventually reached the lower end of the all-season road segment south of Gilles Creek. At that time, impacts from road use would be the same as for Alternative 2, unless public use were restricted.
4.10 Threatened and Endangered Species		
Shaw Creek Hillside all-season road. There would be no impacts on threatened or endangered species. Impacts on sensitive species would be low. Power line. Route would be close to three recently active northern goshawk nests, but would cross relatively little	South Ridge all-season road. There would be no impacts on threatened or endangered species. Impacts on sensitive species would be low. Power line. Route would be close to only	Winter-only access. There would be no impacts on threatened or endangered species. Impacts on sensitive species would be low.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
high-value goshawk habitat.	one recently active northern goshawk nest, but would cross substantially more high value goshawk habitat.	
4.11 Socioeconomics		
Shaw Creek Hillside all-season road. With all-season road, more employees could reside in Delta area because work and off-work periods would be shorter and employees would be bused. With winter-only access, employees would work longer periods, have longer off-work periods, and be flown to and from the site, allowing them to live more distant. Between ~100 and 135 of mine's 385 workers would live in Delta area and create another 30 to 40 jobs in local economy. Mine-related population would be between ~260 and 350 (although not all would be new to Delta area) and would have a substantial and positive local effect. Annual mine-related payroll in the Delta area would be between ~$7.2 and $9.4 million. Effects on the local school system likely would be low, with a slight increase in demand for other public services. Effects on the housing market would be high, and generally positive. Local homeowners could expect to see home values rise, and some new construction could be expected. Road use and disposition. If open to industrial and commercial users during and after Pogo operation, the road would increase access for mineral, timber, and other development, creating additional economic activity, population growth, and demand for public services. If open for everyone, the road would create more economic activity. In either case, local socioeconomic effects likely would be low.	South Ridge all-season road. Same as Alternative 2.	Winter-only access. As discussed under Alternative 2, winter-only access would result in fewer local employees. Between ~40 and 80 workers would live in the Delta area and create another 10 to 15 jobs in the local economy. Mine-related population would be between ~100 and 190 (although not all would be new to Delta area) and have a major and positive local effect. Annual mine-related payroll in the Delta area would be between ~$2.8 million and $5.7 million. Other effects would be the same as for Alternative 2.
4.12 Land Use		
Shaw Creek Hillside all-season road. Land use impacts would be low because all uses would be compatible with adopted land use plans. *Existing* land uses, however, could be substantially *changed*. Richardson Hwy. Egress. Shaw Creek/Rosa option would substantially increase existing use of Shaw Creek	South Ridge all-season road. Impacts would be similar to those for Alternative 2, except that the impacts to existing residential and other users near the Richardson Highway would occur in the vicinity of the highway near Quartz Lake,	Winter-only access. Impacts would be similar to those for Alternative 2, except as noted below. Road use. Access would not be as beneficial to potential commercial/industrial users as an all-season road. New mineral and timber activities, and associated commercial land uses, likely would be slower to

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
Road, while Tenderfoot option would substantially *change* existing land use. Shaw Creek and Richardson Highway areas generally would experience some increase in residential use and development with either option. Road use. Access could substantially benefit new commercial and industrial users. If open to public, the road would provide access to large presently remote areas. Road disposition. Reclaiming the road could be a high impact to new commercial/industrial land uses that occurred because of initial road construction, but existing land uses along Shaw Creek Road would not be substantially affected. If the road were open to the public during project operation, reclaiming would have a high impact on new recreational users and any service businesses that developed to support new backcountry users. Security gate location. Limiting public access to the lower two-thirds of Shaw Creek Valley would substantially reduce likely changes to existing land uses beyond Gilles Creek that would occur if the public were able to use the road to reach the Goodpaster River. DOF road. This road would not be built if the Shaw Creek Hillside all-season road were constructed.	rather than in the Shaw Creek Road area. DOF road. Planned road into the Indian Creek area could cause moderate *changes* in land use, such as timber harvesting in presently uncut areas, but harvests would be compatible with existing land use plans.	develop than with an all-season road. If the road were open to the public, because of its seasonal nature, it would be a benefit to existing residential and recreational users in the Shaw Creek and Goodpaster valleys, including the Goodpaster cabin owners, because users would be able to access the upper reaches of the Shaw Creek and Goodpaster drainages only in winter, which they largely can do now. Trappers, commercial sled dog tour operators, and other backcountry users also would consider winter-only access less of an impact. Potential recreational users, however, would not have increased access to more remote areas during the 9 months when the perennial winter trail would be impassable. DOF road. If the winter-only access option were constructed, the DOF forestry road would be built and eventually would connect with the southern end of the all-season road segment of this winter-only access option. Because the DOF road would be open for public use, all impacts discussed in Alternative 2 likely would occur at least to the point south of Gilles Creek where the roads would connect.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
4.13 Subsistence		
Shaw Creek Hillside all-season road. The road itself would have a low effect on the availability of subsistence resources. Road use and disposition. For access and competition criteria, the most restrictive road use and disposition options (road open only to Pogo project use during mine operations, and removal and reclamation at the end of mine operations) would allow the least access into the Shaw Creek and upper Goodpaster River drainages and would have the fewest impacts. Conversely, the least restrictive options (road open to everyone during and after mine operations) would allow the greatest access and would have the most effects. Opening the road even to just other industrial/commercial users would augment the potential for increased access and competition for resources. It would also complicate enforcement of policies designed to restrict competition with existing resource users. Opening the road to everyone would serve to open a currently inaccessible area to the general public. In addition to the Shaw Creek and Goodpaster River drainages, if hunters and recreationists were able to use the road to cross the Goodpaster River, the road use could ease some of the problems of reaching the high country north and northeast of Healy Lake. Restricting road use to the west side of the Goodpaster River, however, would reduce this possibility. To the extent that opening the road to the general public would result in increased use of this area, this option would have the greatest effect on existing subsistence uses by creating substantially increased access and competition in current use areas for key species for a long time period over a potentially large geographic area, resulting in subsistence users needing increased hunting effort, having greater costs, not going to traditional areas as often, and having reduced harvest. This impact would be major within the local and regional context for present-day subsistence hunters who are descendents and related kin of Athabaskans who used	South Ridge all-season road. Same as Alternative 2, except that subsistence use patterns along the South Ridge route are slightly different.	Winter-only access. This alternative would not allow all-season road access to upper Shaw Creek and the mid-Goodpaster River Valley, thus substantially limiting potential subsistence impacts from increased recreational and other subsistence users. The Shaw Creek Flats portion of the route would cross wetlands and recent and traditional subsistence use areas. Any fuel or cyanide accidents on the flats resulting in resource damage, decline, displacement, or contamination would affect availability to subsistence users, and contamination concerns could lead to reduced resource consumption and years of wondering if the resources from the area as well as “downstream” were safe to eat. Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, subsistence impacts from public use would begin to approach those described for Alternative 2 as the DOF road, which would be open to the public, was extended toward Gilles Creek.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
this area traditionally. At the same time, the recent subsistence use areas are substantially larger than the immediate area of the all-season road. Traditional users may avoid the area because of the new road and traffic, and this avoidance (or social barrier) likely would increase if the road were open to non-Pogo users. In this sense, the road has the potential to be regarded as a loss of a part of one's homeland for hunting, not necessarily the primary or most used hunting area, but a hunting area that was historically and is currently used. Security gate at Gilles Creek. This sub-option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. Access to the mine vicinity and the potential for sport hunters and other recreationists to use the road to cross the Goodpaster River and ease some of the problems of reaching the high country north and northeast of Healy Lake would not exist. Richardson highway egress. The Tenderfoot option would not provide materially greater access to subsistence resources; thus, there would be little difference in effects between this route and the existing Shaw Creek Road. Power line. Because this route would be very close to the Shaw Creek Hillside all-season road, the increased access impacts of the power line would be of little or no additional consequence.		
4.14 Cultural Resources		
Shaw Creek Hillside all-season road. Because adherence to cultural-resource protection procedures under CFR 800, Section 106, is the accepted process by which to mitigate impacts to cultural resources, no major impacts to cultural resources are expected from direct project development. Road use and disposition. Additional road users would increase the likelihood that surface artifacts would be more vulnerable to looting and other types of damage.	South Ridge all-season road. Same as Alternative 2.	Winter-only access. Same as Alternative 2, except limited seasonal access would decrease human presence considerably and surface artifacts and other cultural resources would be less vulnerable to looting and other types of damage.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
4.15 Visual		
Shaw Creek Hillside all-season road and power line. The routes would be along lower elevations of the hillside and would have low impacts on visual resources as viewed from the Richardson Highway. They still would be evident to backcountry users and airborne viewers. Visual impacts would be high to some Shaw Creek Road residents because of the close viewing distance and the substantial contrast to the natural landforms of the hillside. The Goodpaster River Bridge and the power line would have high visual impacts to viewers on the Goodpaster River near the mine site. Richardson highway egress. The Tenderfoot egress option is located in a low VAC area. Development of this option would have moderate to high impacts on the visual resources because of high viewer sensitivity. There would be no impacts with the Shaw Creek Road option. Road use. Impacts would be low from use only by Pogo-related traffic. If other users travel the road, there would be greater disturbances (light and dust) potentially viewable for longer periods. There also would be an increase in vehicle lights during periods of low natural daylight, particularly in winter. Road disposition. Removal and reclamation of the road and power line would have the fewest impacts on visual resources. Current visual appearance would be restored as vegetation reclaimed the corridor. Other options would have an increasing impact in ascending order of industrial/commercial users and open to everyone.	South Ridge all-season road and power line. Because of the more visible higher elevations along the South Ridge slopes, there would be moderate to high impacts on visual resources due to the low VAC, the sensitivity of concerned viewers, and their proximity to foreground, middle-ground, and background views. The impacts to visual resources would be considered high to Goodpaster River cabin owners and Goodpaster River Winter Trail users. These impacts would be inconsistent with the visual guidelines of the Tanana Basin Area Plan (TBAP). The proposed road corridor would not be visible from the elevation of Quartz Lake; however, the power line would be somewhat visible from the lake in the middle ground at a distance of ~2 miles. Road use. Because this alternative would have higher visual impacts than Alternative 2, use by others than the Pogo project would have correspondingly greater impacts than Alternative 2. Road disposition. Same as for Alternative 2, except that because the visual impacts of this alternative would be greater than for Alternative 2, they would remain longer before vegetation obscured them.	Winter-only access. This route on Shaw Creek Flats would not be visible from the Richardson Highway because of the low elevation of the flats and its high VAC. Overall impacts would be low because of the high VAC of the Shaw Creek Flats and hillside areas. Road Use. Use of the winter-only access route by users other than the Pogo project would have low visual impacts because of the nature of a winter-only access and its limited window of operations compared to an all-season road in Alternatives 2 and 3. Road disposition. Impacts for the all-season road segment would be the same as for Alternative 2. The Shaw Creek Flats winter-only access segment simply would not be used again for Pogo purposes and would be available for use by anyone, much as a majority of the route is today.
4.16 Recreation		
Richardson Highway egress. The Shaw Creek/Rosa option would not have high impacts on existing or prospective recreation users. The Tenderfoot option would have a high positive effect on prospective recreational users because this route presently is	Road use and disposition. Same as Alternative 2, except there would be somewhat more impacts on the Goodpaster Valley recreational cabin owners because parts of the access road	Winter-only access. Road use. Because the purpose of winter-only access would be to limit public access to the Shaw Creek and Goodpaster valleys, it would not be open for public use. If use were limited to Pogo-related traffic or other

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
undeveloped. Road use and disposition. Use by Pogo and other industrial or commercial users only, and removal and reclamation after mine closure, would have a high impact on prospective motorized recreational users, but would not have a high impact on existing recreational users. Permanent access open to everyone would have a high impact on existing recreational users desiring remote and primitive recreational experiences. With access, the Goodpaster River Bridge could become a popular launching site for floaters and fishers and bring them into the lower river and past cabins. This river use could change the present relative isolation of the cabins, and could cause changes in fishing bag and size limits, as well as an increase in littering and vandalism. Security gate location. This sub-option would have the same impacts described above for road use by everyone, except the impacts would only occur in the lower two-thirds of Shaw Creek Valley. Impacts to Goodpaster recreational cabin owners and other existing recreational users north of Gilles Creek would not occur. Potential recreational users, however, would not receive the benefits of easy access to the mid-Goodpaster River	would be visible from the cabins.	industrial/commercial users, it would lower the quality of existing nonmotorized recreational experiences, but this effect would be limited to the area of the road corridor. Because this alternative would reduce new recreational motorized vehicles, it would not affect traditional recreational experiences in the primitive and semi-primitive motorized areas as much. Snow machines still would use traditional routes to access these areas, however. There would be few impacts on recreational cabin owners on the lower Goodpaster River because the Goodpaster River Bridge would not be accessible to floaters and fishers, as would occur for Alternatives 2 and 3. Although road use by the public could be restricted on the winter-only access segment on Shaw Creek Flats, recreational impacts from public use would begin to approach those described for Alternative 2 as the DOF road, which would be open to the public, was extended toward Gilles Creek.
4.17 Safety		
Shaw Creek Road egress. This option would cause some safety risk for the six year-round residences along the road. Overall, mine-related vehicle use would average between 10 and 20 round trips per day. During intense periods of mine construction, traffic would average ~50 vehicles per day. If the Applicant's shift-change bus station were located near the TAPS crossing, there would be two, approximately one-hour periods every 4 days, during each of which up to 180 vehicles would traverse the road. If the bus station were located on the Richardson Highway, the number of vehicles during each of these periods would be reduced to approximately six buses.	South Ridge all-season road. Impacts similar to those for Alternative 2, but somewhat higher because of the greater current traffic level on Quartz Lake Road. In winter, this route would subject traffic to higher winds, drifting snow, and poorer visibility than would the Shaw Creek Hillside all-season route because of its considerably longer segment above timberline.	Winter-only access. Use of winter-only access would require moving large volumes of supplies during a relatively short window under very cold and dark conditions that would be more likely to cause accidents. While the safety risk would be low, it would be tangible and higher than that associated with an all-season road. Road use. If winter-only access were open to everyone, there would be a moderate safety risk. Maintaining traffic control under these conditions just for Pogo project trucks would be a challenge. If other users were to be on the winter road/trail at the same time, the chances of an accident, particularly with a

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but <u>Related to</u> <u>Surface Access</u>

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
The former location option would have a higher safety risk along Shaw Creek Road than would the latter location. Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State of Alaska has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. Because the road could be upgraded in the future if necessary, speed limits could be adjusted if appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low. DOT/PF may have to conduct a traffic impacts analysis, in conjunction with issuance of a drive way permit, which may result in specific mitigation measures being required. <u>Tenderfoot egress</u>. This option would have low safety impacts. Its use would eliminate the Shaw Creek Road safety issue. <u>Road use</u>. Opening the road to other users would cause a small increase in the safety risk to residents identified above. The increased risk would be due to more traffic (public and logging operations), and because typical users likely would not be as observant of speed limits as would drivers under specific direction from the Applicant. The safety risk, while increased, would still be low. <u>Road disposition</u>. If the road were to remain open to other users after mine closure, this safety risk would continue. <u>Security gate location</u>. If the road were closed to public use with a security gate near the end of the existing Shaw Creek Road, public use of the road would be very restricted and impacts would be low. If the road were completely open to public use, traffic on Shaw Creek Road would increase substantially, compared to present traffic, and impacts would be increased. A security gate at Gilles Creek likely would reduce public use measurably because it would prevent access to the last half of the road, but traffic still would be considerably		snow machine, would be substantially higher.

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
higher than if the security gate were located near the end of Shaw Creek Road. Safety impacts, however, still would be low.		
4.18 Technical and Economic Feasibility		
Tenderfoot egress. Although constructible, the route would cross difficult terrain, with poor soils and likely permafrost. Deep incised gullies indicate loess deposits that would require deep side hill cuts. Ascent and decent segments would require 5 to 7 percent grades for approximately 1.5 miles on each side of the ridge. Switchbacks would be required, with several curves having a radius less than the design criterion for 500 ft, and possibly less than the minimum of 300 ft. This option would require construction of an essentially new, ~3.5-mile road to the vicinity of the end of the existing Shaw Creek Road. A reasonable construction cost estimate is ~$2.5 million to 3.0 million to avoid using the existing Shaw Creek Road.	South Ridge all-season road. Soil and topography conditions along the first several miles of this route are difficult. They are characterized by steep slopes, many small drainages, and probable ice-rich soils, compared with good terrain and soil conditions on the Shaw Creek Hillside route. The steep slopes and angular talus in the vicinity of Shaw Creek Dome along the South Ridge route likely would make construction difficult. The elevated and exposed terrain, and severe winds experienced in the Delta region, would make maintenance more difficult and driving more hazardous, especially in blowing snow conditions. This route would be expected to be available for use approximately 10 fewer days than would the Shaw Creek Hillside route.	Winter-only access. Technical feasibility. The focus of this issue is whether annual winter-only access would be feasible for the life of the mine. The Applicant estimates that adequate winter supply window would be absent once in 13 years. Recent data confirming long-term climate warming in central Alaska may mean Applicant's estimate is optimistic. Economic feasibility. Constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-ft airstrip for remainder of year, raises many economic feasibility issues. ▪ A short window would be available for mobilization of construction equipment and supplies for the development phase, including construction of the all-season road segment. ▪ Annual resupply of almost a year's worth of fuel, equipment, and materials would need to occur during 8- to 10-week window. During the rest of the year, the project would be dependent solely on air support susceptible to weather interruptions and capacity constraints. ▪ Winter-only access capital costs are estimated at approximately 53 percent higher than all-season road. A year's worth of diesel, propane, cement, reagents, and other materials must be stored. Additional construction costs would be required for air support for personnel, fuel, food, and supplies, as well as for equipment standby rentals while waiting for demobilization the next winter. Extended project and contractor overheads would result. Power line construction would be more expensive because 15 fewer miles of adjacent road would be

Table 5.1-3 Summary of Direct and Indirect Effects of Options Specific to Alternatives, but Related to Surface Access

Alternative 2 (Shaw Creek Hillside)	**Alternative 3** (South Ridge Corridor)	**Alternative 4** (Shaw Creek Flats Winter-only Access)
		available. ■ Total annualized operating costs are estimated at approximately 118 percent higher than for the all-season road. Freight is estimated to cost approximately 60 percent more per ton. Personnel air transportation costs would be very substantial. Additional rental costs would be incurred for idled shipping containers awaiting next winter's resupply window. Cement would need to be bagged for shipment, rather than handled in bulk. Finance costs for the stored inventory would be incurred. Power line maintenance would be more costly. ■ Winter-only access would add substantial capital and operating costs and increase the project's economic burden, and introduce an unreasonable level of complexity and business risk. ■ This increased economic burden and unreasonable business risk were considered to have a major impact on the project's economic feasibility.

5.2 Identification of the Environmentally Preferable and Preferred Alternatives

In making its Record of Decision (ROD), EPA must identify both an Environmentally Preferable Alternative and a Preferred Alternative. The Environmentally Preferable Alternative "ordinarily, means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources" (CEQ, 1981: Forty most asked questions, no. 6a). The Environmentally Preferable Alternative can be the same as the agency Preferred Alternative or differ in some respects, depending on the analysis in the EIS.

The Preferred Alternative is the alternative EPA and the cooperating agencies believe fulfills the purpose and need of the Proposed Action. As provided for in NEPA and the CEQ NEPA implementing regulations, the Preferred Alternative and the Environmentally Preferable Alternative need not be the same. EPA may take into account various other considerations in choosing its Preferred Alternative, including such factors as the agency's statutory mission and responsibilities and economic, environmental, technical, and social factors (CEQ, 1981: Forty most asked questions, no. 4a).

This section analyzes the impacts summarized in Tables 5.1-1, 5.1-2, and 5.1-3, compares them on an individual component basis, and determines which options should constitute both the Environmentally Preferable Alternative and EPA's and the cooperating agencies' Preferred Alternative.

5.2.1 Options Common to All Alternatives

By definition, the options common to all alternatives would be developed regardless of which of the three actions alternatives were selected. Of the ten project components with options common to all alternatives, eight had no sub-options that differed between the three action alternatives (Table 2.5-1). Two components, however, did have options that would produce different impacts; gravel source, and use and disposition of the airstrip.

Gravel Source

Mining Gravel Versus Crushing Development Rock Gravel is on the critical path for project construction. It would be needed for two purposes immediately at the start of development; for concrete aggregate for the civil works' foundations in the mine area (water treatment plant, mill, camp, and shop facilities), and as a road topping for mine area roads. Crushing development rock for gravel at this early stage would not be an option. Most of the nonmineralized rock that would be generated from underground would not be available until later in the two-year project development period. Underground mine development must follow completion of the appropriate surface facilities described above. Advancing underground development before beginning the surface civil works isn't possible because you cannot treat mine water without a new water treatment plant, and you cannot have underground development without a shop to maintain the equipment. Thus, from a timing perspective, crushing development rock to make gravel would not be feasible or practicable.

From another perspective, experience during the Pogo Mine exploration phase has demonstrated that underground development rock does not make a good traffic surface for high volume roads. At the existing advanced exploration facilities, gravel has been used to top the surface of the high volume roads because the development rock breaks down under traffic loads and becomes mud. Thus, from a technical perspective, crushing development rock to make gravel would not be feasible or practicable. Also, a gravel road topping has helped to reduce sedimentation both on the surface and underground, where reduced sedimentation in the mine sumps has been an important factor in water treatment plant efficiency.

Another need for gravel may arise for topping portions of the mine access road. Test work at potential material sites along the proposed Shaw Creek Hillside road alignment has shown the rock in most of the proposed material sites does not conform to ATM T-13 degradation, or to Los Angeles Abrasion ASTM C131-96 specification for coarse abrasion testing of coarse rock (Shannon and Wilson, Inc., 1999, 2000). Thus, while the rock from these sites would still be suitable for bulk fill, topping material with sufficient hardness for the road surface would have to be hauled long distances from select material sites. Two of the material sites may contain rock suitable for crushing and use for road topping, and it would be advantageous in some areas for the Applicant to do so rather than haul gravel from the vicinity of the mine. Some of the gravel from the mine area sites, however, could be used for access road topping.

Even if nonmineralized development rock were suitable for crushing, which it is not, the direct cost to produce approximately 140,000 cu yd of aggregate for use in the mine area would be approximately three to four times greater than mining pit run gravel by expanding existing borrow pits and developing new ones as proposed by the Applicant. A reasonable cost estimate for pit run gravel at the Pogo site is approximately $4 per cu yd. Thus, crushed development rock would cost between approximately $1.1 million and $1.7 million more than mined gravel (Rowley, 2002a).

Mining gravel from existing and new pits versus crushing nonmineralized development rock for gravel would disturb approximately 66 more acres. As discussed later, the off-river treatment works was selected as the preferred option for the industrial wastewater discharge component. Because this option would require excavation of approximately 13.1 acres of gravel to create the two ponds, a portion of the overall project‘s required mine area gravel needs would be met during excavation of the ponds, and the 66-acre total would be reduced to approximately 53 acres. A portion of this disturbance would be to wetlands, and would have moderate impacts. But those impacts would be offset by pond creation in the gravel pits, resulting in negligible overall wetlands impact. Mining gravel would have a moderate local wildlife habitat impact although this, too, would be mitigated somewhat by pond formation. Still, surface mining of gravel would account for approximately 7 percent of the total surface disturbance for the Applicant’s Proposed Project.

Summary analysis of these two options indicated that from the timing and technical perspectives, crushing development rock to make gravel would not be feasible or practicable. For the gravel mining option, overall impacts to wetlands and wildlife would be low to moderate on a local basis, with some positive benefits from newly created ponds in the gravel pits. And, construction of the off-river treatment works would require excavating approximately 13.1 acres of gravel in any event, thus lowering the overall mined gravel acreage. Also, gravel mining is a common practice in Alaska and its management and reclamation are well understood by regulatory agencies.

If the crushed development rock option were feasible and practicable, it likely would be considered the Environmentally Preferable Alternative. This option originally was considered as a result of scoping comments, but further analysis of the sequence and timing of project development and when gravel would be needed, as well as the inferior hardness specifications of the crushed rock itself, has shown the crushed development rock option not feasible or practicable. Therefore the option to mine gravel was selected as the Preferred Alternative, and by default also as the Environmentally Preferable Alternative.

Air Access

- **Airstrip Use and Disposition** Direct impacts generally would be low regardless of whether airstrip use were restricted only to the Pogo project or to the Pogo project and other industrial/commercial users. If the airstrip were open for use by everyone during mine operations, however, impacts would be higher for all resources, except new recreational users, who would benefit from increased access.

  With respect to disposition, removal and reclamation of the airstrip would be beneficial to most resources, but would have a negative impact on potential industrial/commercial users as well as recreationists, who would lose access to the mid-Goodpaster River Valley.

  Summary analysis indicated that allowing airstrip use by other industrial/commercial users or everyone during operations would have more impacts than restricting use only to the Pogo project. In a similar manner, removing and reclaiming the airstrip would have fewer impacts on most resources, and the area land use plan does not call for creating access to the mid-Goodpaster River Valley. Therefore, for both the Environmentally Preferable Alternative and the Preferred Alternative, use only by the Pogo project was selected as the airstrip use option, and removal and reclamation was selected as the airstrip disposition option.

5.2.2 Options Specific to Alternatives, but Not Surface Access Related

Three project components had options that were specific to one of the three action alternatives, but were not surface access related (Table 2.5-2).

Tailings Facility Liner

- ✦ **Lined Versus Unlined Tailings Dry Stack and RTP** Evaluation of seepage that would occur from unlined surface dry stack and RTP facilities indicated impacts would be low because of the low permeability of both the underlying rock as well as the dry-stack tailings themselves, and the RTP design.

  Dry-stack tailings pile Permeabilities of the fine-grained dry-stack tailings themselves were not considered to be greatly different than permeabilities of an installed liner system. Also, most seepage that would occur from the dry stack would be captured by the RTP. Still, from strictly a water quality perspective, a lined tailings facility likely would provide some measure of increased impermeability and transmission of drainage to the RTP. From a tailings pile stability perspective, however, a liner would be more problematic.

  The original dry-stack tailings pile stability analysis assumed a worst case scenario that included saturation of the general tailings placement zone. It did not include saturation of the shell zone. Placement of an impermeable liner beneath the general placement zone likely would cause saturation of the tailings pile and result in occurrence of the worst case scenario, which was not the design intent. Thus, saturation caused by the impervious liner likely would increase stability risk.

Because there would be little benefit to water quality from installation of a liner under the dry-stack tailings pile, while there would be increased risk to stability from the liner, the unlined dry stack sub-option was selected as both the Environmentally Preferable Alternative and the Preferred Alternative.

In the Applicant's Proposed Project, there would be no erosion control/drainage blanket installed before tailings would be placed in the dry-stack tailings facility. This blanket was predicted to have no effect on the dry stack's stability, but it would permit clearing and stockpiling of organic and soil growth media to insure a sufficient volume for reclamation. Because of this benefit, inclusion of a erosion control/drainage blanket was selected for both the Environmentally Preferable Alternative and Preferred Alternative.

RTP The primary purpose of the RTP would be to capture runoff and seepage from the dry-stack tailings facility consistently, reliably, thoroughly, and predictably, during both mine operations and post closure activities.

Seepage from the dry stack would migrate downgradient below the surface, nearer the colluvium/weathered bedrock interface. An effective seepage interception and collection system would be needed to provide appropriate management of this subsurface flow. Given the nature of the flow system that would develop, the most effective interception system would be one perpendicular to the direction of subsurface flow, i.e., a cutoff wall.

The proposed RTP dam face liner system and grout curtain would establish an effective interception cutoff wall to collect this seepage. The upstream toe of the dam face liner system would be embedded in a trench in weathered bedrock filled with grout, with a drilled curtain of pressure-grouted holes extending below the toe through the weathered bedrock layer and into fresh bedrock.

A full liner under the RTP basin would not provide substantially better long term seepage collection and would introduce increased operational and performance risks for a number of reasons, including:

- A full basin liner would fail to collect the seepage at issue because the upstream toe of the liner would not have the robust cutoff wall required to collect the subsurface seepage. If such a cutoff wall at the upgradient end of the liner were required, it would follow that another liner upstream of that cutoff wall also would be needed, etc. It is thus a cutoff wall perpendicular to the flow that would be needed to capture seepage, not a liner.
- Due to the narrowness of Liese Creek Valley, and its steep slopes, hydrostatic uplifting forces from upwelling ground water beneath the liner could result in long-term liner instability, especially during periods when the RTP reservoir would be drawn down to provide storm surge volume.
- The nature of Liese Creek Valley geometry is such that a large portion of any full basin liner would be on very steep slopes. The south slopes of the

reservoir exceed the maximum slopes recommended for effective liner installation (2.2 to 2.5 H to 1 V).

Because a full basin liner thus would not completely capture the desired seepage and provide the long-term reliability necessary to manage dry-stack seepage, and because the geometry of the site exceeds recommended slopes for effective installation of a liner, the unlined option was selected for both the Environmentally Preferable Alternative and the Preferred Alternative.

Power Supply

- **Power Line Versus On-site Generation** Analysis indicated the primary issues were surface disturbance from the power line option versus the risk of fuel spills from the on-site generation option. A power line would clear vegetation from approximately 602 or 525 acres, depending on the route. This clearing, however, generally would not damage the vegetative mat. The disturbance caused by additional fuel storage tanks for on-site generation would be approximately 22.7 acres with the winter-only access option.

  On-site generation, however, would require an additional approximately 4.2 million gallons of fuel to be trucked to and stored at the mine site. For five resources (water quality, wetlands, fish, wildlife, and subsistence), the risks of spills from the seven-fold increase in fuel volume that would be trucked to the mine site were considered high.

  From the land use and socioeconomics perspectives, the on-site generation option was inferior because it would not provide the opportunity for power for other potential industrial/commercial users. For recreation, a power line ROW could provide additional backcountry access for new users, depending to what extent mitigation measures were implemented to limit access. Such access, however, would be an impact on existing backcountry users. Only for visual resources was the on-site generation option considered more favorable because a power line would have high visual impacts.

  Summary analysis indicated that, for the majority of resources, the risks from fuel spills during transportation were considered to be considerably more important than the impacts from ROW clearing and the visual impacts of a power line. The impacts from ROW clearing were considered less important because clearing generally would not destroy the vegetative mat, and once the power line were reclaimed, plant succession would eventually return the ROW to approximately its present condition. Visual impacts of a power line were considered less important because power line reclamation would remove the visual impacts of the poles and lines and plant succession would eliminate remaining visual impacts. Thus, the power line was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

Water Discharge

Development Phase

- **Underground Injection Wells** The existing water treatment plant at Pogo has discharged treated mine drainage via an injection well at approximately 100 gpm since 1999. Every monthly sample during the four-year period since has met all the permit limits of the existing injection well permit. As the mine workings increase over the first two years of development, however, the amount of water to be discharged could increase to approximately 400 gpm. And, the farther one gets in both space and time from the existing conditions the more potential there would be for mine drainage water quality to diverge from that observed during the past four years. There would be potential for discharged water to surface in nearby sloughs, and the projected treated water may not meet discharge criteria for three parameters at least some of the time. This would be considered a moderate impact from a permitting and compliance perspective.

- **Direct Discharge to Goodpaster** Treated wastewater would be discharged directly to the Goodpaster River. Water quality at the edge of the mixing zone was projected to meet discharge criteria for all parameters. The impact of this discharge was expected to be low.

  A mixing zone could not be approved if there were potential for mercury to bioaccumulate to significantly adverse levels [18 AAC 70.250 (a)(1)(A)]. It was uncertain whether mercury would bioaccumulate to significantly adverse levels from this discharge; hence, it was uncertain whether a mixing zone could be granted.

- **Off-River Treatment Works** This option was expected to have efficient mixing of treated wastewater, thus meeting criteria for all parameters even at the conservative 95th percentile of the annual maximum. The impact of this discharge was expected to be low.

Summary analysis of the development-phase discharge options determined that for the underground injection wells option, as the development workings expand there would be greater potential that the discharge may not meet criteria for three parameters at least some of the time. This inability to meet discharge criteria was considered a moderate impact from a permitting and compliance perspective. For the direct discharge option, it was unknown whether a mixing zone could be granted because of the lack of certainty about whether mercury would bioaccumulate. In contrast, the off-river treatment works option was expected to have a low impact and more permitting certainty. Thus, the off-river treatment works was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

Operations Phase

This subcomponent had the same three options for treated wastewater as for the development phase, plus discharge to an SAS. Impacts from the three options in common with the development phase would be the same as discussed above for the that phase.

- **Soil Absorption System** The influent to the SAS is expected to achieve drinking water standards for the 95^{th} percentile of the annual average for all parameters except nitrate, and is expected to exceed TDS, chloride, sulfate, TKN, and nitrate for the 95^{th} percentile of the annual maximum. The effluent from the SAS is expected to exceed the discharge criteria for the 95^{th} percentile of the annual average based on dissolved and total concentrations for nitrate, cyanide, cadmium, copper, and lead. The 95^{th} percentile of the annual average would also exceed the total recoverable criteria for manganese. For the 95th percentile of the annual maximum, TDS, chloride, sulfate, nickel, and selenium would be exceeded for dissolved and total criteria in addition to those exceeded for the annual average. Manganese would also be exceeded for total criteria only. These additional parameters at the 95th percentile of the annual maximum would likely exceed the discharge criteria less frequently than for the 95th annual average. Because the influent to the SAS and the discharge from the SAS are estimated to exceed the expected discharge criteria for a number of parameters, this discharge was defined as having a high impact from a permitting and compliance perspective, and may not be permittable.

Summary analysis for the operations phase options determined the same impacts as described for the same development phase options, in addition to the high permitting and compliance impact for the SAS option. Thus, in the same manner as for the development phase, the off-river treatment works was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

5.2.3 Surface Access-Related Options Specific to Alternatives

Two project components had surface access-related options specific to the three action alternatives: surface access and power line route (Table 2.5-3).

Surface Access

The surface access component had three subcomponents: route, use, and disposition.

Route There were three route options: Shaw Creek Hillside all-season road, South Ridge all-season road, and the Shaw Creek Flats winter-only access.

- **Winter-only Access** In the first step to determine the preferred surface access option, the concept of winter-only access was compared to the all-season road concept. Implementation of each concept would have advantages over the other. From the technical and economic feasibility perspectives, however, the winter-only access concept would not work. Technically, the issue was whether the annual winter-only access option would be feasible during the life of the mine. The Applicant estimated that a winter supply window allowing adequate time would be absent once in 13 years. Independent confirmation of recent long-term climate warming in central Alaska suggested the Applicant's estimate was optimistic.

  From an economic feasibility perspective, constructing, operating, and reclaiming a remote mine dependent on only 8 to 10 weeks of annual surface access for major resupply, with reliance of air support into a 3,000-ft airstrip susceptible to weather interruptions for the remainder of the year, raised many issues. These issues included a short window for mobilization of construction equipment and supplies for the development phase, including construction of the all-season road segment; capital costs estimated to be approximately 53 percent higher than for an all-season road; storage of an entire year's worth of diesel, propane, cement, reagents, and other materials at the mine; and total annualized operating costs estimated to be approximately 118 percent higher than for an all-season road, with freight estimated to cost approximately 60 percent more per ton and with substantial personnel air transportation costs.

  Thus, because winter-only access might not be possible for 1 or more years during the expected mine life, and because it would add substantial capital and operating costs that would increase the project's economic burden, it would introduce an unreasonable level of complexity and business risk. Therefore, this option did not address the purpose and need for the Proposed Action, and could not be considered further for the Preferred Alternative.

- **All-season Road** In the second step to determine the preferred surface access option, the Shaw Creek Hillside all-season route and South Ridge all-season route options were compared. For purposes of the analysis, impacts from the associated power line routes also were considered because, taken as a whole, building both the road and power line in conjunction would substantially reduce total impacts from both components. Analysis showed each set of options (for the road and power line) to have advantages over the other.

The South Ridge route had advantages in that it would cause approximately 79 fewer acres of total surface disturbance for both the all-season road and power line ROWs, and approximately 45 fewer acres of cuts and fills in wetlands. It also would cross only one stream requiring a bridge (the Goodpaster River), versus seven for the Shaw Creek Hillside route. This route had disadvantages in that soil and topographic conditions would be difficult for construction, and the elevated and exposed terrain would make maintenance more difficult and driving more hazardous, especially in blowing snow conditions. This route also was expected to be available for use approximately 10 fewer days than for the Shaw Creek Hillside route.

The Shaw Creek Hillside route had advantages in that it would disturb roughly half the acreage of high-value habitats for moose, caribou, and brown bear than would the South Ridge route, and bird-power line collisions likely would be fewer because of its more extended length below timberline. Visual impacts also would be fewer than for the South Ridge route because it would be primarily below timberline, and the Shaw Creek Hillside route would not be visible to the recreational cabin owners on the lower Goodpaster River. The Shaw Creek Hillside all-season road, therefore, would be more consistent with the visual guidelines of the TBAP, which call for consideration of visual impacts on the Goodpaster River corridor.

In most cases, these differences in impacts between the two routes were not considered to be high on greater than a local basis, largely because the route corridors would be narrow and linear in character, and because mitigation measures would reduce impacts. For example, the 79 more acres of total surface disturbance for both the all-season road and power line ROWs and the 45 more acres of fills and cuts in wetlands for the Shaw Creek Hillside route would occur over a distance of 49.5 miles. The six additional stream crossings for the Shaw Creek Hillside route all would be made with bridges that would permit free movement of water and fish. Conversely, the greater South Ridge route impacts to high-value wildlife habitat would occur to only a small portion of similar habitats found in the project area.

The overriding difference between the routes, however, was related to land use. Based on the long-term TVSF management plan, the current DOF 5-year timber harvest plan includes an initial forestry road to the Keystone Bluffs area of the state forest, and eventually well up the Shaw Creek Valley to upper Gilles Creek. Therefore, within the expected life of the Pogo Mine, there is a reasonable probability that a public road up to 23 miles long would be constructed very close to the proposed Shaw Creek Hillside all-season road alignment as far as Gilles Creek if the Applicant's proposed road were not constructed. Thus, because there were no major differences in impacts between the two route options that could not be mitigated to some extent, and because constructing the Shaw Creek Hillside route would result in only one road being built into the project area (i.e., not both the South Ridge all-season road and the DOF forestry road), the Shaw Creek Hillside route was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

For the Shaw Creek Hillside all-season road option there was an issue of which route would be used to connect the all-season road to the Richardson Highway.

- **Richardson Highway Egress** There were two route sub-options for this road segment: the existing Shaw Creek Road and Tenderfoot.

  For most resources, there were no or only minor differences between the two sub-options. The Shaw Creek Road sub-option had higher noise and safety impacts and would not be as favorable to new recreational users because no new area would be accessed. The Tenderfoot sub-option was determined to have higher visual and cost impacts. Of these, the noise, safety, and cost impacts were judged to be of most importance.

  For the Shaw Creek Road sub-option, both the safety and noise impacts generally were considered low. From the safety perspective, some increased impact would occur, especially if the all-season road were open to use by everyone and the shift change bus station were located near the TAPS crossing. This increased impact, however, could largely be mitigated. From the noise perspective, impacts generally would be low or moderate. If the Applicant's shift change bus station were near the TAPS crossing, however, two residences would experience a moderate to high impact, and four would experience a high impact during short periods of time four days apart. These impacts also could be mitigated to some extent, including locating the bus station on the Richardson Highway.

  Shaw Creek Road is relatively narrow at present, but is well maintained and has been improved recently. The State has reviewed expected traffic volumes and vehicle sizes, including logging truck traffic from proposed DOF timber sales and shift change traffic, and believes Shaw Creek Road can accommodate this traffic safely. Because the road could be upgraded in the future if necessary, speed limits could be adjusted and other mitigation measures implemented as appropriate, and the Applicant's policy would be to adhere to all speed limits, the safety risk from Pogo-related traffic would be low.

  For the Tenderfoot sub-option, the cost of a new, approximately 3.5-mile road was estimated at approximately $2.5 million to $3.0 million. This road would terminate in the vicinity of the end of the existing Shaw Creek Road, which already is a state-maintained road.

  In final analysis, it was determined that it would be unreasonable to build a new road merely to avoid an existing state-maintained road, considering that the Shaw Creek Road noise and safety impacts generally would be low or could be mitigated to make them low.

- **Use** For road use during Pogo project operations, there were three options:

  - **Pogo Project Use Only**
  - **Pogo Project and Other Industrial/Commercial Users**
  - **Use by Everyone**

  For almost all resources, impacts were considered to be low from the regulated use of an all-season road only by the Pogo project, and were considered only marginally higher for additional regulated use by other industrial/commercial users. Impacts from the option with use of the road by everyone were considered generally low for several resources (water and air quality, noise, wildlife, and visual), and moderate for fish. For three resources, however, impacts were considered high.

Because off-road use by ATVs and other vehicles generally is not regulated, a road open to everyone could cause major impacts to wetlands. It also would increase competition for subsistence resources. For existing recreationists, road use by everyone could have a major impact on the quality of their experiences, particularly for cabin owners along the lower Goodpaster River. Conversely, from the perspective of new recreationists, use by everyone would be beneficial because it would provide access to new areas.

In determining its preferred option, the ADNR considered its overall, broad management goals under the TBAP, as well as the more specific management objectives of the TVSF plan. Because (1) the Shaw Creek Hillside route would be both within or immediately adjacent to the state forest in lower Shaw Creek Valley; (2) an objective of the forest plan is to provide public access to forest resources; and (3) state forest roads generally are open to the public; ADNR made a proposed determination that the lower approximately 23 miles of the Shaw Creek Hillside all-season road as far as Gilles Creek would be open to public use during mine life following Pogo project construction, and published that preliminary decision in the DEIS. The proposed determination would have kept the remaining approximately 26 miles of road to the mine open only for use by the Pogo project, and possibly to other industrial/commercial users on a case-by-case basis. Such other use could occur, however, only after a public process and thorough analysis of potential impacts of the proposed uses.

Public and Tribal comments on ADNR's preliminary decision, however, were over-whelming opposed to opening any of the Shaw Creek Hillside all-season road past the end of the existing Shaw Creek Road to the public during the life of the Pogo Mine. ADNR, therefore, is reconsidering its preliminary decision and the EIS team has selected use of the entire mine access road during the life of the mine only by the Pogo project, and by other industrial/commercial users on a case-by-case basis, as the Preferred Alternative for purposes of this final EIS. ADNR will consider whether to adopt this option in its final decision based on its review of, and comments received on, this final EIS. Use of the entire road only by the Pogo project (with no use by other industrial/commercial users) was determined to be the option for the Environmentally Preferable Alternative.

- **Disposition** There were two all-season road disposition options:
  - **Remove and Reclaim the Road**
  - **Maintain the Road**

Results of this analysis were similar to those for the road use options discussed above. The primary difference was that the option for road use during mine operations had a limited time horizon while road disposition following Pogo Mine closure was considered to be permanent. Continued road use only by industrial/commercial users was considered to have low impacts on most resources, although locally high impacts on wetlands and wildlife could happen if major resource developments were to occur.

Leaving the road open to everyone would perpetuate many of the same impacts described in the Chapter 4 alternatives analysis of the option to permit road use by everyone. In addition, it would lead to the cumulative impacts of maintaining an all-season road also described in that chapter. As discussed in Chapter 4, the degree of impacts if the road were to be maintained, particularly cumulative impacts, could be reduced in large measure by the State of Alaska land use and road management policies.

The probability of another mine or other large resource development occurring in the area prior to Pogo Mine closure is low. The TVSF Management Plan, however, contemplates public use of state forest roads. Therefore, ADNR made a preliminary determination in the DEIS that the ROW authorization for the Shaw Creek Hillside all-season road would require that at Pogo Mine closure the all-season road must be removed and reclaimed from Gilles Creek to the mine site in its entirety, and in a manner that would preclude use by ATVs. The segment from the existing Shaw Creek Road to Gilles Creek, however, would remain open for all users. ADNR could extend the life of the road to the mine site to accommodate other major resource development projects, but only after a public process that would include a thorough analysis of potential impacts of the proposed uses.

Comments on ADNR's preliminary disposition decision strongly favored opening the mine access road as far as Gilles Creek after the life of the mine. Thus, because the TVSF Management Plan contemplates public use of state forest roads, and because there was strong support for public use of the road after the mine's life, public use and retention of the road as far as Gilles Creek was determined to be the Preferred Alternative, while removal and reclamation of the entire all-season road was determined to be the Environmentally Preferable Alternative.

Power Line Route

The power line route component had two options:

- **Shaw Creek Hillside**
- **South Ridge**

Although these two options had different impacts for various resources, a constant throughout the power line route analysis was that the power line route should be the same as the surface access route because, taken as a whole, building both in conjunction would substantially reduce total impacts from both components. Because overall impacts from the surface access route would be substantially greater than those for the power line route, and because neither power line route offered any substantial benefits over the other, once the surface access route was selected, the choice of the corresponding power line route was straightforward. Thus, the Shaw Creek Hillside power line route was determined to be the option for both the Environmentally Preferable Alternative and the Preferred Alternative.

In the Applicant's Proposed Project, the power line would cross the Shaw Creek / Goodpaster divide via Sutton Creek (Figure 2.3-2), to the north and away from the road corridor. As a result of public comments on the DEIS, a new sub-option was considered with the power line following the road corridor over the divide. The road corridor route would have approximately the same direct habitat impact as the Sutton Creek route, and marginally greater wetlands impacts, but would consolidate impacts into one corridor and avoid all impacts to the Sutton Creek drainage. Thus, the road corridor sub-option was selected for both the Environmentally Preferable Alternative and the Preferred Alternative.

5.3 Presentation of the Environmentally Preferable and Preferred Alternatives

Based on the analyses in Section 5.2 immediately above, Tables 5.3-1, 5.3-2, and 5.3-3 present the Environmentally Preferable Alternative, as well as EPA's and the cooperating agencies' Preferred Alternative.

Figure 5.3-1 presents EPA's and the cooperating agencies' Preferred Alternative in graphic form in the same manner as was shown in Figure 4.0-1, except the options that constitute the Preferred Alternative are boldly framed.

The options and sub-options selected for the Environmentally Preferable Alternative and the Preferred Alternative were the same for every project component with the exception of disposition of the Shaw Creek Hillside all-season road. For this subcomponent, the Environmentally Preferable Alternative was complete removal and reclamation of the road. In the Preferred Alternative, disposition of the road was the same as for the Environmentally Preferable Alternative past Gilles Creek. Between the existing Shaw Creek Road and Gilles Creek, however, the road would be maintained for public use following mine closure.

Table 5.3-1 Environmentally Preferable Alternative and Preferred Alternative for the Options Common to All Action Alternatives

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Milling Process		
▶ Gravity / flotation / cyanide vat leach[1]	X	X
Tailings Disposal		
▶ Underground paste backfill	X	X
▶ Surface dry stack and RTP in Liese Creek Valley	X	X
Mill and Camp Location		
▶ Liese Creek Valley	X	X
Development Rock Disposal		
▶ Mineralized rock encapsulated in dry stack	X	X
▶ Nonmineralized rock in dry stack, RTP dam, other construction	X	X
Gravel Source		
▶ Expand existing gravel pits and develop new pits	X	X
▶ Crush nonmineralized development rock		
Construction Camp		
▶ Below existing 1525 Portal in Goodpaster Valley	X	X
Laydown Area		
▶ Permanent below existing 1525 Portal, at airstrip, and at mill	X	X
Water Supply		
Industrial		
▶ Mine drainage	X	X
▶ RTP	X	X
▶ Wells	X	X
Domestic		
▶ Wells	X	X
Water Discharge		
Operations Phase		
▶ Domestic wastewater		
✦ Package treatment plant and direct discharge to river	X	X
Fuel Storage Location		
▶ Temp: 1525 Portal and airstrip. Perm: portal mouth and mill	X	X
Air Access		
▶ 3,000-ft. airstrip in Goodpaster Valley	X	X
Use		
▶ Pogo project only	X	X
▶ Pogo and other industrial / commercial users only		
▶ Everyone		
Disposition		
▶ Remove and reclaim after mine reclamation	X	X
▶ Open for Industrial / commercial resource users only		
▶ Open for everyone		

[1] Underline – Applicant's proposed option or sub-option

Table 5.3-2 Environmentally Preferable Alternative and Preferred Alternative for the Options Specific to Certain Action Alternatives, but Not Related to Surface Access

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Tailings Facility Liner		
▶ Surface dry stack and RTP in Liese Creek[1]	X	X
✦ Lined dry stack		
✦ Lined RTP		
✦ Unlined dry stack	X	X
✦ Unlined RTP	X	X
Power Supply		
▶ Power line	X	X
▶ On-site generation		
Water Discharge		
Development Phase		
▶ Underground injection wells		
▶ Direct discharge to Goodpaster River		
▶ Off-river treatment works	X	X
Operations Phase		
▶ Soil absorption system (SAS)		
✦ Goodpaster River Valley adjacent to airstrip		
✦ Saddle above and southeast of Pogo Ridge		
▶ Underground injection wells		
▶ Direct discharge to Goodpaster River		
▶ Off-river treatment works	X	X

[1] Underline – Applicant's proposed option or sub-option

Table 5.3-3 Environmentally Preferable Alternative and Preferred Alternative for the Options Specific to Certain Action Alternatives that are Related to Surface Access

Component, Options, and Sub-Options	Environ. Preferable Alternative	Preferred Alternative
Surface Access		
Route		
▶ Shaw Creek Hillside all-season road[1]	X	X
✦ Shaw Creek Road egress from Richardson Highway	X	X
✦ New Tenderfoot egress from Richardson Highway		
▶ South Ridge all-season road		
▶ Shaw Creek Flats winter-only access		
✦ Traditional winter road construction standards		
✦ Perennial winter trail construction standards		
Use		
▶ Pogo project only	X	
▶ Pogo and industrial/commercial users		X
▶ Everyone		
✦ Security gate near end of Shaw Creek Road	X	X
✦ Security gate at Gilles Creek		
Disposition		
▶ Remove and reclaim — entirely	X	
▶ Remove and reclaim — past Gilles Creek gate		X
▶ Leave road open as far as Gilles Creek (vs. closed) to:		
✦ Industrial/commercial users	X	
✦ Everyone		X
Power Line Route		
▶ Shaw Creek Hillside	X	X
▶ South Ridge		

[1] Underline – Applicant's proposed option or sub-option

PREFERRED ALTERNATIVE (Shown In Bold Frames)

AN ALTERNATIVE TO BE ANALYZED IN THIS EIS[1] =	COMPONENTS NOT SURFACE ACCESS RELATED				COMPONENTS SURFACE ACCESS RELATED				
			WATER DISCHARGE		ACCESS				
	TAILINGS FACILITY LINER +	POWER SUPPLY +	DEVELOPMENT PHASE +	OPERATIONS PHASE +	TYPE +	ROUTE +	USE +	DISPOSITION +	POWER LINE ROUTE
	Options	Options	Options	Options	Options	Options	Options	Options	Options
ALTERNATIVE 1 NO ACTION	Under the **No Action Alternative,** the project would not be developed and none of the options below would be implemented.								
ALTERNATIVE 2 Applicant's Proposed Project	**Unlined**	**Power Line**	Injection Wells	▪ Injection Wells, and ▪ SAS ◆ At Airstrip ◆ Above Pogo Ridge	**All-Season Road**	**Shaw Creek Hillside Richardson Egress ▪ Shaw Creek Road** ▪ Tenderfoot	**Pogo Project Only[2]** Pogo and: ◆ Industrial/ Commercial ◆ Everyone	**Remove/Reclaim[3]** **Road Left Open to: ◆ Industrial/ Commercial[4] ◆ Everyone[4]**	**Shaw Creek Hillside**
ALTERNATIVE 3 South Ridge Route Direct Discharge	Lined	"	Direct Discharge to Goodpaster River	Direct Discharge to Goodpaster River	"	South Ridge	"	"	South Ridge
ALTERNATIVE 4 Winter Only Access Off-River Treatment Works	"	On-Site Generation	**Off-River Treatment Works**	**Off-River Treatment Works**	Winter Access Only	Shaw Creek Flats	N/A[5]	N/A	N/A
Major Options Eliminated From Further Consideration[6]			Constructed Wetlands		Railroad; Air Only (5,000-ft Airstrip)	Richardson Egress: ▪ Pipeline ▪ Keystone; Dean Cummings Crossing; Goodpaster Valley		Convert to Recreational Trail	

[1] Excludes those components/options common to all alternatives (Table 5.3-1).
[2] Entire access road past end of existing Shaw Creek Road
[3] Past Gilles Creek
[4] Up to Gilles Creek
[5] Not applicable to this alternative.
[6] See Appendix A.1.

Figure 5.3-1

Chapter 6 References

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Chapter 7 Compliance with Environmental Laws and Executive Orders

In its role as lead federal agency for the Pogo Mine Environmental Impact Statement (EIS), the U.S. Environmental Protection Agency (EPA) is required to demonstrate compliance with certain environmental laws and executive orders (EOs). The purpose of this chapter is to demonstrate how EPA has so complied.

Each specific act or EO is addressed below. The discussion cites the implementing regulations or policies, presents a brief summary of the applicability of the act or EO, and describes how the Pogo Mine EIS process has complied with it.

7.1 Clean Air Act

Air Quality Act of 1967 (42 United States Code [USC] 7401* et seq.*), as amended in 1970 (Clean Air Act)

Four sections of the Clean Air Act must be considered by EPA during the EIS process.

General Conformity

Regulations **40 Code of Federal Regulations (CFR) Parts 6, 51, and 93**

Applicability

General Conformity, as outlined in Section 176, applies to all federal activities other than those by the Federal Highway Administration (FHWA) and the Federal Transit Administration, in nonattainment and maintenance areas. The purpose of General Conformity is to ensure that any federal action does not cause or contribute to any violation of a National Ambient Air Quality Standard (NAAQS).

Pogo EIS Compliance

Not applicable because the project is not located in a nonattainment or maintenance area.

Transportation Conformity

Regulations **40 CFR Part 93**

Applicability

Transportation Conformity requires EPA and the U.S. Department of Transportation (USDOT), along with local governmental agencies, to integrate air quality planning with transportation planning in areas of nonattainment or maintenance.

Pogo EIS Compliance

Not applicable because the project is not located in a nonattainment or maintenance area.

Air Toxics

Regulations **40 CFR Parts 61 and 63**

Applicability

Section 112 requires that emissions standards be developed for hazardous air pollutants. These standards are entitled National Emissions Standards for Hazardous Air Pollutants. One hundred eighty-nine toxic air pollutants were listed to be reduced. Major sources and area sources also were listed to be regulated by source category. However, Section 112 only applies to federal actions that emit pollutants in a designated source category. In addition, the source must be categorized as a major source of emissions.

Pogo EIS compliance

Not applicable because the project would not be a major source of toxic air pollutants.

Prevention of Significant Deterioration

Regulations **40 CFR §52.21 and §51.166**

Applicability

Prevention of Significant Deterioration (PSD) was created to manage industrial growth in NAAQS attainment areas to prevent degradation of air quality. PSD programs are usually implemented by the states, and state programs must be approved by the EPA as meeting minimal requirements. Three major criteria determine whether PSD requirements apply to a project. First, the project must be defined as a major source. Second, whether the source is or would be located in a PSD area must be defined. Third, whether a regulated pollutant would be emitted must be identified.

Pogo EIS Compliance

While the Pogo project would emit regulated pollutants and is in a PSD area, it is not defined as a major source. The Alaska Department of Environmental Conservation (ADEC) has determined that a PSD permit would not be required.

7.2 Clean Water Act (CWA)

Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act)

Two sections of the Clean Water Act must be considered by EPA during the EIS process.

Wetlands Protection (Section 404)

Regulations **40 CFR Parts 230 and 231 and 45 CFR 85344**

Applicability

Section 404 of the CWA was written to minimize impacts to waters of the United States (including wetlands) by regulating the discharge of dredged and/or fill material. This section provides authorities to both the EPA and the COE as regulatory agencies. The COE issues permits authoriziing the discharge of dredged and fill material according to the Section 404(b)(1) guidelines established by the EPA. The COE cannot issue a

Section 404 permit unless it has been confirmed that a project is in compliance with these guidelines. As the lead agency, EPA must provide a discussion of how the proposed project complies with Section 404(b)(1) guidelines. Permits to discharge dredged or fill material may only be issued if the Applicant has demostrated to the maximum extent practicable: the avoidance of wetland impacts, the minimization of potential impacts, and if determined necessary, compensatory mitigation as appropriate for any unavoidable impacts.

Pogo EIS Compliance

Both EPA, as lead federal agency for the Pogo Mine EIS, and the COE, as a cooperating agency, will ensure that the proposed permitted action would be in compliance with the CWA Section 404(b)(1) guidelines. The permit will be denied if the discharge would not comply with the guidelines. The mechanism to ensure compliance will be the Section 404 application and review process, which will require adherence to the Section 404(b)(1) guidelines before a permit would be issued. The COE evaluation critera and procedures (including the public notice) are outlined in Appendix B of this final EIS. Chapter 3 of this document describes the baseline wetland conditions in the proposed project area, and Chapter 4 contains specific acreages for wetlands that would be disturbed for each alternative.

National Pollutant Elimination Discharge System (Section 402)

Regulations **40 CFR Parts 122, 123, 124, 125, and 440**

Applicability

Section 402 establishes the National Pollutant Discharge Elimination System (NPDES) permit program that regulates the discharge of pollutants from point sources into waters of the United States. To obtain an NPDES permit, a new gold mining project like the Pogo project must comply with EPA's New Source Performance Standards (NSPS), which can be found at 40 CFR 440.104. NSPS for the ore mining and dressing point source category require adherence to technology-based effluent limits for several metals, pH, and total suspended solids. An NPDES permit may also impose water quality-based effluent limits to ensure that a facility's discharge complies with applicable water quality standards when technology-based requirements are insufficient to meet those standards.

Pogo EIS Compliance

The Applicant submitted a new source NPDES permit application on August 1, 2000, and an amended application on January 2, 2003. This EIS has been prepared to fulfill EPA's NEPA requirement and support its review of that NPDES permit application.

7.3 Noise Control Act

Regulations **CFR 40 Parts 201, 202, 204, 205, and 211**

Applicability

The Noise Control Act was created to coordinate federal research on noise, authorize federal noise emission standards, and provide information to the public about noise reduction. Two agencies regulate noise standards: the Occupational Safety and Health Administration (OSHA) and the Federal Aviation Administration (FAA). OSHA deals only with workplace standards, while the FAA concentrates on aircraft standards. EPA considers noise impacts as part of its Section 309 review of all EISs, and discusses possible noise impacts of the action in its EISs.

Pogo EIS Compliance

Chapter 3 of the EIS presents baseline noise conditions in the proposed project area and identifies human receptors. Detailed predictions of project-related noise levels at these receptors, including existing residents along Shaw Creek Road, are presented in Chapter 4. No high impacts are expected. Noise effects on wildlife are discussed. Noise levels within the mill and camp complex would be addressed by OSHA.

7.4 Safe Drinking Water Act

Regulations 40 CFR 141 through 149

Applicability

The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The SDWA authorizes the EPA to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. EPA, states, and water systems then work together to make sure these standards are met.

Pogo EIS Compliance

The SDWA standards apply to both the quality of the drinking water supplied to the domestic camp and to the quality of waste water discharged from the project to the Goodpaster River. The Applicant and the EIS team conducted extensive analyses of potential water quality impacts to ensure protection of both drinking water and aquatic life in the Goodpaster River system. The results of these analyses are presented in Chapter 4 of the EIS.

7.5 National Historic Preservation Act

Regulations 36 CFR Parts 61, 63, 65, 68, 79, and 800

Applicability

The National Historic Preservation Act (NHPA), as amended, directs federal agencies to integrate historic preservation into all activities that either directly or indirectly involve land use decisions. Before approving or carrying out a federal, federally assisted, or federally licensed undertaking, Section 106 of the NHPA requires federal agencies to take into consideration the impact that the action may have on historic properties that are included on, or are eligible for inclusion on, the National Register of Historic Places. Section 106 also requires that federal agencies provide the Advisory Council on Historic Preservation (ACHP) with the opportunity to comment on the undertaking. The Section 106 review process is usually carried out as part of a formal consultation with the State Historic Preservation Officer (SHPO), the ACHP, and any other parties, such as Indian Tribes that have knowledge of, or a particular interest in, historic resources in the project area. Formal consultation is concluded upon preparation of a Memorandum of Agreement among the consulting parties that addresses the treatment of any adverse effects.

Pogo EIS Compliance

EPA as lead federal agency and the COE as a cooperating agency each have Section 106 responsibilities for the proposed project. The project has been subjected to Section 106 review, including participation by the SHPO.

In addition, a cultural resources workshop with Native organizations and individuals to gather information relating to cultural resource in the Pogo mine project area was carried out on August 21, 22, and 23, 2001, in Tok, Dot Lake, and Fairbanks and on September 24, 2001, in Anchorage. Interviews were coordinated by the Healy Lake Traditional Council and were attended by Native individuals from throughout the region. A separate, stand-alone report titled *Results of Native Consultations Concerning Cultural Resources in the Pogo Mine Area of Potential Effect, Cultural Resources Trip Report* (Harritt, 2001) was developed to document these consultations.

EPA, as lead federal agency, in consultation with the COE and the SHPO, has determined that some cultural resources sites may meet the following three criteria: (1) they could be eligible for the National Register of Historic Places under 36 CFR 60.4; (2) they could be adversely affected by construction of the Pogo project; and (3) they have not yet been mitigated under permits previously issued by the SHPO. These sites, therefore, could require mitigation under a programmatic agreement (PA) among the EPA, COE, ACHP, SHPO, and the Applicant. The PA contains provisions for discovery of prehistoric, historic, or paleontological remains during construction, operation, and closure of the Pogo Mine. The PA is provided as Appendix C.1 of this final EIS.

7.6 Endangered Species Act

Regulations 50 CFR Parts 402, 450, 451, 452, and 453

Applicability

The Endangered Species Act (ESA) requires that federal agencies protect and conserve endangered and threatened species. Federal agencies are responsible for reviewing possible effects that their actions may have on any listed threatened or endangered species or their critical habitats. If the federal agency determines that the project may affect a listed species or critical habitats, it must initiate consultation with either the U.S. Fish and Wildlife Service (USFWS),National Marine Fisheries Service (NMFS), or both. Projects that are funded, authorized, or carried out by federal agencies must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of their habitat.

Pogo EIS Compliance

Informal ESA consultations were initiated by EPA with the USFWS and NMFS by letter on August 14, 2000. On September 7, 2000, the USFWS responded that there are no threatened or endangered species in the project area. The service noted that the recently delisted American Peregrine Falcon (*Falco peregrinus anatum*) nested within the project area. It concluded, however, that the proposed project and associated activities are not likely to adversely affect peregrine falcons. Because of delay in the EIS schedule, on September 25, 2002, and on May 9, 2003, USFWS again stated there are no threatened or endangered species in the project area.

EPA again requested informal consultation with the NMFS on December 2, 2002. On December 23, 2002, NMFS responded that no endangered species under NMFS jurisdiction are likely to occur in the vicinity of the project site, and critical habitat for listed species does not occur in the project vicinity. NMFS also stated that no marine mammals protected under the Marine Mammals Protection Act are expected to occur in the vicinity of the project site.

Copies of these documents are contained in Appendix C.2 of this final EIS.

7.7 Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat

Regulations **50 CFR Part 600**

Applicability

The Magnuson-Stevens Fishery Conservation and Management Act establishes eight regional fishery management councils that are responsible for preparing fishery management plans for optimum yield. Fishery management councils are to submit these plans, including the identification of essential fish habitat (EFH), to the Secretary of Commerce. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Federal agencies must consult with the NMFS for any action that may adversely affect EFH. NMFS is responsible under Section 305(b) to compile information on EFH and make it available to other federal and state agencies. This requirement can be satisfied under National Environmental Policy Act (NEPA) review.

Pogo EIS Compliance

On August 14, 2000, EPA sent NMFS a copy of the Pogo Mine EIS scoping document and requested an EFH managed species and habitat list. On December 2, 2002, EPA again requested an EFH managed species list. EPA prepared a draft EFH assessment and found there would be no direct, indirect, or cumulative impacts on any EFH within the Pogo project area. That draft EFH assessment was contained in Appendix F.3.2 of the Draft EIS (DEIS), and a copy of that document was sent to NMFS for its review with a request that it specifically comment on the adequacy of the draft EFH assessment. On May 19, 2003, the NMFS responded that it concurred with EPA's assessment that no substantial adverse individual or cumulative effects of EFH are expected in the project area. A copy of this letter is contained in Appendix C.3 of this final EIS.

7.8 Floodplain Management Executive Order

Executive Order **11988 (May 24, 1977)**

Regulations

EPA implementing procedures are outlined in "Statement of Procedures on Floodplain Management and Wetlands Protection," 40 CFR Part 6 (January 5, 1979).

Applicability

The Floodplain Management Executive Order requires that federal agencies avoid long- and short-term impacts to floodplains to the greatest extent possible. This EO calls for federal agencies to avoid impacts associated with the occupancy and modifications of floodplains and to avoid support of floodplain development wherever there is a practicable alternative. According to the "Floodplain Management Guidelines," there is a multi-step, decision-making process that must be fulfilled by federal agencies to help them avoid adverse impacts. The steps include the following: determining if a proposed action would indeed be in a floodplain, conducting public review of the action, identifying and evaluating alternative plans and sites, assessing possible impacts, development of mitigation measures, and informing the public of decisions made. Various actions are subject to this order: acquiring, managing, or disposing of federal lands or facilities; federally created, financed, or assisted construction or improvements; and federal activities that affect land use.

Pogo EIS Compliance

Pursuant to the floodplain management guidelines, EPA has determined that portions of the proposed Pogo Mine project would be in the floodplain of the Goodpaster River. Through the EIS process, which provides a public review of the proposed project, EPA has identified and evaluated project components and alternative sites outside the Goodpaster floodplain, and has developed mitigation measures.

With only one exception, the major mine area facilities would be located permanently in Liese Creek Valley well above the Goodpaster River floodplain. The temporary components that would be within the floodplain during the 2- to 3-year construction period largely would be the already existing exploration camp infrastructure below the present 1525 Portal that would be used to house workers and store materials and supplies. These facilities include the worker camp, offices, fuel storage, and helipad. These facilities would be removed and reclaimed once construction was completed. The existing temporary mineralized and nonmineralized rock storage piles near the 1525 Portal would be moved out of the floodplain during the mine development phase.

Certain other temporary facilities would be developed within the Goodpaster floodplain during the construction period. These facilities include additional gravel pits pits, a concrete batch plant, construction laydown area, and overburden stock piles. These facilities also would be removed and reclaimed after construction.

New facilities or existing facilities that would be within or remain within the floodplain for the duration of project operation would be existing and future gravel pits (including the off-river water treatment works), water supply and underground injection wells, the 3,000-foot airstrip, and the access road.

EPA identified and analyzed alternative sites for the airstrip outside the floodplain, but concluded that because of topography and weather constraints, other sites posed considerable safety hazards and were not deemed practicable (Appendix A.1.).

7.9 Wetlands Protection Executive Order

Executive Order 11990 (May 24, 1977)

Regulations

Implementing procedures are outlined in Appendix A of 40 CFR Part 6, “Statement of Procedures on Floodplain Management and Wetlands Protection” (January 5, 1979).

Applicability

The Wetlands Protection Executive Order seeks to minimize destruction, loss, or degradation to wetlands from federal actions on federal lands. Wherever effects to wetlands cannot be avoided, federal agencies are to include all practicable measures to minimize adverse impacts. The EO applies to acquisition, management, and disposition of federal lands and facilities, construction/improvement projects in conjunction with a federal agency, and federal activities/programs that affect land use. Because no federal lands would be involved with permitting the Pogo project, this EO does not apply to the project.

Pogo EIS Compliance

While this EO is not applicable to the Pogo project, both EPA, as lead federal agency for the Pogo Mine EIS, and the COE, as a cooperating agency, have ensured that the proposed project would be in compliance with the CWA Section 404(b)(1) guidelines before it would be allowed to proceed. How the guidelines would be met is described above in Section 7.2.1 (Wetlands Protection).

7.10 Migratory Bird Protection Executive Order

Executive Order 13186 (January 10, 2001)

Regulations None

Applicability

The Migratory Bird Protection Executive Order directs all federal agencies to avoid or minimize the impacts of their actions on migratory birds, and to take active steps to protect birds and their habitat. It directs that agencies ensure that environmental analyses of federal actions required by the NEPA or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern.

Pogo EIS Compliance

This EIS addresses migratory bird species and specifically discusses the species of concern. Chapter 3 presents project area baseline information for these species, and Chapter 4 discusses impacts and mitigation measures that would be taken to minimize impacts.

7.11 Environmental Justice Executive Order

Executive Order 12898 (February 11, 1994)

Applicability

The Environmental Justice (EJ) Executive Order directs federal agencies to develop environmental justice 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), with the goal of making EJ a part of their mission and achieving environmental protection for all communities. The EO recognizes the importance of research, data collection, and analysis, particularly with respect to multiple and cumulative exposures to environmental hazards. The EO also provides for agencies to collect, maintain, and analyze information on patterns of subsistence consumption of fish, vegetation, or wildlife. Additionally, the EO stresses access to public information on, and an opportunity for public participation in, matters relating to human health and the environment.

The memorandum that accompanied the EO highlights important ways for federal agencies to consider EJ under NEPA. These include identifying the affected area to determine if minority populations or low-income populations would be affected, analyzing the effects of the agencies' actions on minority populations and low-income populations, evaluating public health data, and assessing possible cultural, social, or historical factors that may be affected by the action. Mitigation measures identified as part of the NEPA process should address significant and adverse environmental effects of proposed actions on minority populations and low-income populations. Moreover, agencies are required to provide opportunities for effective community participation in the NEPA process.

Pogo EIS Compliance

To identify minority and low-income populations in the potentially affected project area, the most recent available census data (1990) was collected and compared with 1980 and 1970 data to ensure that any developing growth trends in minority populations were identified. This analysis, coupled with the collection of anecdotal data in Delta Junction and the surrounding area, suggested that three population groups warranted further research to ensure compliance with the EJ EO:

Native American population

Russian population

- Korean population

Native American Population

While the Government-to-Government (G2G) EO goes a long way toward ensuring that Native American populations have meaningful participation in the environmental assessment of projects that may affect them, the EJ EO seeks to address all potential remaining issues. EPA has both overlapping and separate responsibilities when it comes to communities and Tribes. EJ addresses low-income and people-of-color communities. Native Americans are considered people of color under the EJ EO, and Native Americans in the vicinity of the project area largely fall under the low-income criterion also. Under EJ, EPA needs to have meaningful public participation with all communities that would be disproportionately affected. This public participation can be different from the G2G consultations that EPA has with Tribes. EJ also addresses issues that Tribal Governments do not officially raise, but that may be raised by tribal members that are not part of the government (Letourneau, 2001).

To comply with the EJ EO, EPA made a special effort to encourage individual tribal members to identify issues of concern during the scoping process whether or not they were members of the Tribal Government. In fact, all residents in the 13 villages identified as potentially affected were added to the project mailing list.

The 13 Tribes listed below were considered to be potentially affected by the proposed Pogo Gold Mine project by virtue of their location: (1) within a 125-mile radius of the Pogo Mine site, or (2) within the potentially affected Tanana River watershed.

- Circle Native Community
- Dot Lake Village Council
- Healy Lake Tribal Council
- Native Village of Tanana
- Nenana Native Village
- Northway Traditional Council

- Manley Village Tribal Council
- Mentasta Traditional Council
- Native Village of Eagle
- Native Village of Minto
- Tanacross Village Council
- Tetlin Village Council
- Tok Traditional Council

The consultation efforts that were undertaken by EPA to ensure the EJ EO requirements for Native Americans and the Consultation and Coordination with Indian Tribal Governments EO requirements that were addressed are presented in detail in Section 7.13 of this document.

In addition to the special outreach efforts described in Section 7.13, the following sections of this document include information germane to compliance with the EJ EO:

- Sections 3.16 and 4.11 Socioeconomics
- Sections 3.17 and 4.12 Land Use
- Sections 3.18 and 4.13 Subsistence
- Sections 3.19 and 4.14 Cultural Resources

Subsistence Another effort to comply with the EJ EO was adoption of the State of Alaska's expansive definition of subsistence for impacts analysis in this document. As defined by Alaska Statutes (AS), "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 nonedible 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" (AS 16.05.940[32]). Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

Specific consultations with Native organizations and individuals relating to potential subsistence and cultural resource impacts of the Pogo mine project were carried out on August 21, 22, and 23, 2001, in Tok, Dot Lake, and Fairbanks, and on September 24, 2001, in Anchorage. These consultations provided opportunities for the actual users to identify subsistence resources regardless of the formal definition of subsistence. Interviews were coordinated by the Healy Lake Traditional Council and were attended by Native individuals from throughout the region. A separate, stand-alone subsistence report titled *Subsistence Uses of the Upper Tanana River Valley: Historical and Contemporary Patterns* (Stephen R. Braund & Associates [SRB&A, 2002a]) was developed to document these consultations. This report was submitted in draft form to the Healy Lake Tribal Council for comment, and its comments were incorporated into the final report.

Through the G2G process, Native concerns and mitigation measures suggested by Native representatives to address those concerns were identified by the communities that would be potentially affected. These concerns and mitigation measures are discussed in Sections 3.18 and 4.13 of this EIS, which address subsistence issues, including seasonal use of the project area.

Cultural resources Measures taken during the EIS process to protect Native American cultural resources are described in Section 7.5 (NHPA) of this chapter.

Russian Population

While census data had not yet picked up the substantial in-migrating Russian population in the Delta Junction area at the time of scoping, anecdotal research did. Further research through the Delta Greely School District (DGSD) confirmed that within the last 6 years, Russian families had begun moving to Delta Junction at a high rate. Individuals of Russian nationality do not qualify specifically as a minority under the EJ EO; however, because a majority of the Russian population of the Delta area meets the EO's low-income criterion, the Russian community was considered to fall under the EJ EO.

It was determined that while many of the younger members of these families were taking English classes at a special program at the local school, most did not speak or read English. To make sure this demographic participated meaningfully in the EIS process, a translator was hired to translate the first newsletter into Russian, and 300 copies were distributed within the community. Interviews with locally elected officials and with school district officials in Delta Junction revealed it would be much more effective to distribute the newsletters through the local Russian Orthodox church than by other methods, including a mailing list. The Russian Orthodox minister was contacted to confirm that this method would be most effective; he stated that word of mouth was the best communication methodology with this demographic group. It was decided to proceed with the translation of the first newsletter anyway, and then evaluate its effectiveness.

Subsequent interviews with the Russian Orthodox minister, the local Russian translator, and the DGSD indicated the newsletter approach had not been very effective; however, EPA also obtained permission for the newsletter to be read aloud to the English/Russian language program 1 week before the EIS scoping open house in Delta Junction. The director of the English as a Second Language program reported that a majority of the Russian adults in Delta Junction were enrolled in the English language classes, and that he would be happy to make the newsletter the subject of one of the translation classes. All those interviewed reported this method had been very effective and recommended using it for all future communications with this demographic group. It was also decided that the Russian Orthodox minister would be used as a liaison with the Russian community, a role in which he serves effectively on other community issues.

Korean Population

The small Delta area Korean community falls under the EJ EO definition of a minority community. Therefore, in an effort to gain a more thorough understanding of the communication support needs of the Korean community in Delta Junction, EPA worked through the Presbytery of the Yukon to locate the minister of the Korean church in Delta Junction. Pastor Sun Ae Carpenter presides over a congregation of 11 Korean women in Delta Junction. She stated with certainty that this number represents the total number of Korean residents in Delta Junction. Although these 11 individuals are all Korean nationals, they are all fluent in English. Without exception, they are married to ex-military personnel who have retired from service at the local U.S. Army Base, Fort Greely. She stated that the former population of 30 Korean community members shrank between 1998 and 2001 when Fort Greely began the decommissioning process. Local school district demographics confirmed this. Based on the remaining Korean population's communication skills and their marital integration into the community, it was determined that EPA's normal outreach efforts would adequately address this demographic group.

7.12 Protection of Children from Environmental Risks Executive Order

Executive Order 13045 (April 21, 1997)

Applicability

The EO recognizes that a growing body of scientific knowledge demonstrates children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. Federal agencies are directed to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children, and to ensure their policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

Pogo EIS Compliance

This EO is not applicable because the mine is located more than 30 miles from the nearest settled area containing children, and because the project would operate under air, water, and other environmental permits designed to meet accepted standards.

7.13 Consultation and Coordination with Indian Tribal Governments Executive Order

Executive Order 13084 (November 6, 2000)

Applicability

The Consultation and Coordination with Indian Tribal Governments Executive Order directs federal agencies to establish regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, strengthen the G2G relationships with Indian Tribes, and reduce the imposition of unfunded mandates upon Indian Tribes. EPA Region 10 views “consultation" to mean the process of seeking, discussing, and considering the views of federally recognized Tribal Governments at the earliest time in EPA’s decision-making. Consultation generally means more than simply providing information about what the agency is planning to do and allowing comment. Rather, consultation means two-way communication that works toward a consensus reflecting the concerns of the affected federally recognized Tribe(s).

In addition, EPA Region 10 has developed a set of internal guiding principles to further facilitate G2G consultation.

- The Region will consult with federally recognized Tribal Governments in a sensitive manner respectful of tribal sovereignty and culture.
- The Region will maintain G2G communications with federally recognized Tribal Governments by interacting through officials of appropriate stature and authority as determined by the Regional Administrator and Tribal Government. For major

consultation issues, the time frame and manner in which EPA will consult with a specific Tribe will be negotiated between EPA and the Tribe.

- In situations for which EPA has the ultimate decision-making authority, federal policies direct EPA to consult with affected federally recognized Tribal Governments prior to decision-making.
- On specific matters, the Region should contact and provide any available materials necessary to the potentially affected federally recognized Tribes as early as practicable, to provide time for consultation prior to making a decision.
- Where feasible and appropriate, the Region will encourage regular participation of federally recognized elected tribal representatives or their designees on regional planning groups and work groups.
- The Region will directly notify federally recognized Tribe(s) when specific tribal interest or trust resources may be involved, and offer the respective Tribe(s) an opportunity to participate without resolving whether the Tribe(s) has a legal right to consultation.
- The Region will meet with individual federally recognized Tribes upon request of the Tribe's leaders.
- The Region should endeavor to build an ongoing relationship with each federally recognized Tribal Government(s) to increase communication, and to ensure that consultation on specific proposals will be more constructive and effective.
- The Region will encourage meetings with federally recognized Tribal Governments on their homelands, to the extent resources allow, to strengthen the EPA federal-tribal relationship and facilitate EPA understanding of respective tribal issues, concerns, and perspectives.
- Public participation, which involves individual citizens of Indian Country, is not the same as consultation with affected federally recognized Tribal Governments. EPA has the responsibility to consult with federally recognized Tribal Governments separate from, and in addition to, the public participation process for interested stakeholders.
- Consultation with Tribal Governments should occur independent of the public participation process. tribal consultation does not replace requirements to promote public participation that may apply to a given proposed federal action.

Should disputes arise between one or more Tribes and EPA Region 10, the parties will strive to address the matter informally, at the staff level. In the event that staff are unable to resolve a dispute, the issue will be presented to immediate supervisors, who will attempt to resolve the dispute. If the dispute is not resolved, the staffs will present the matter to progressively higher levels of management until consensus is reached. In the event consensus is not reached, the EPA Regional Administrator, after consulting with the elected leader(s) of the federally recognized Tribe(s), will make the final decision.

Pogo EIS Compliance

To comply with the G2G EO requirement to achieve meaningful consultation during the EIS process, the EPA Tribal Office's first effort was to work with the NPDES permit writer to determine which Tribes it considered to be potentially affected by the proposed Pogo Gold Mine project. Then EPA contacted the Tribe closest to the proposed project to discuss the proposed criteria for identifying potentially affected Tribes. After several discussions, the 13 Tribes listed below were determined to be potentially affected by the project by virtue of their location: (1) within a 125-mile radius of the Pogo Mine site, or (2) within the potentially affected Tanana River watershed.

- Circle Native Community
- Dot Lake Village Council
- Healy Lake Tribal Council
- Manley Village Tribal Council
- Mentasta Traditional Council
- Native Village of Eagle
- Native Village of Minto
- Native Village of Tanana
- Nenana Native Village
- Northway Traditional Council
- Tanacross Village Council
- Tetlin Village Council
- Tok Traditional Council

EPA then worked with these Tribes to develop a plan that would ensure each would not only be fully informed and able to comment on the proposed project, but also be able to consult and influence the approach that would be used to ensure meaningful G2G consultation. The G2G consultations that have occurred to date since commencement of the EIS process are presented below in Table 7.13-1.

The COE, as a cooperating federal agency for the Pogo Mine EIS, has stated it will follow EPA's lead throughout the NEPA process. The Corps will participate as practical in all meetings and tribal teleconferences with the various tribal entities throughout the EIS process. However, if it is determined that direct formal tribal consultation is necessary, then the COE Alaska District would proceed as stated in these guidance documents: (1) Department of Defense American Indian and Alaska Native Policy, and (2) U.S. Corps of Engineers Tribal Policy Principles dated April 1998.

The Alaska Department of Natural Resources (ADNR) coordinates the State of Alaska's consultation with the 13 potentially affected Tribal Governments. ADNR conducted a face-to-face consultation with these Tribal Governments during the scoping phase of the Pogo Mine project EIS to solicit comments and provide clarification on those portions of the EIS process that relate to the management of state land, including access issues. ADNR has been and remains available to meet with Tribes if invited to do so, and this cooperating agency has contacted the Tribes during key stages of the process, and will continue to do so as it finalizes its decisions and authorizations. Any comments received from the Tribes will be considered in developing the State of Alaska's decisions on its authorizations, and will also be forwarded to the entire EIS team.

Table 7.13-1 Pogo Mine EIS Process G2G Communications/Consultations

Date	Action
8/11/00	13 potentially affected Tribes identified; Draft G2G Consultation Plan and Scoping Document mailed to each Tribe for review and comment. EPA initiated follow-up fax and phone calls to each Tribe to invite them to participate in a teleconference with agency representatives to discuss (1) mutually agreeable consultation process and (2) issues to be addressed in the EIS.
8/31/00	Invitation to Tribes to participate in cumulative impacts assessment training in Seattle
9/4 and 9/19/00	Written and follow-up telephonic invitations from EPA to Tribes to attend 9/26/00 teleconference with permitting agencies to discuss tribal concerns to be addressed in EIS.
9/25/00	EPA face-to-face consultation with Healy Lake Tribal Council in the village to discuss proposed project description and scoping issues that Tribes considered important to address in the EIS.

Table 7.13-1 Pogo Mine EIS Process G2G Communications/Consultations

Date	Action
9/25/00	Follow-up invitations to Tribes to participate in 9/26/00 afternoon teleconference.
9/26/00	Scheduled teleconference with tribal representatives in Delta Junction to discuss and receive comments on Scoping Document; no tribal members logged on during open line of 1 hour 15 minutes. Tanana Chiefs Conference Environmental Tech for Healy Lake, Tanacross, Northway, Dot Lake, Tetlin, and Tok (not an official tribal rep) outlined issues of concern per her reading of the Scoping Document.
9/26/00, 9/27/00	Advertised public open houses held in Delta Junction and Fairbanks: opportunity for tribal members not resident in villages to participate.
9/27/00	EPA met with Tanana Chiefs Conference officials to research appropriate G2G consultation procedures.
10/5/00	Mailed Draft Scoping Responsiveness Summary document to 13 Tribes.
11/9/00	Telephone consultation with Tribes to discuss Draft Scoping Responsiveness Summary document.
11/10/00	Distributed again the Draft Scoping Responsiveness Summary document to Tribes for review and comment.
11/20-11/22/00	Follow-up phone calls to Tribes to confirm receipt of Draft Scoping Responsiveness Summary document.
11/23/00	Repeat mailing of Draft Scoping Responsiveness Summary document to Tribes.
1/01	8-page EPA project state update mailed to all village residents summarizing proposed G2G consultation process, requesting feedback, and offering contact information for agency decision-makers.
1/6/01	EPA e-mail sent to Tribes requesting input for Pogo EIS update article on issues of tribal concern.
1/9/01, 1/16/01	Invitation to 13 Tribes to participate in 1/16/01 teleconference to consult on Draft Scoping Responsiveness document.
1/16/01	EPA tribal consultation to discuss Draft Scoping Responsiveness Summary document and collect comments. Tribal participants: Healy Lake, Minto, Nenana, Tanana, Tanacross, and Tetlin. Also Tanana Chiefs Conference (Tok) and Yukon River Inter-Tribal Watershed Council. Agency participants: EPA, COE, ADNR.
1/24/01, 2/13/01	Invitation to 13 Tribes to participate in 2/14/01 COE tribal consultation.
2/14/01	COE tribal discussions (telephonic) to discuss and receive comments on (1) appropriate Section 106 implementation, and (2) cultural resource issues/comments. Tribal participants: Healy Lake, Minto, Nenana, Northway and Tanana. Also: Tanana Chiefs Conference. Agency participants: COE, EPA, ADNR.
3/8/01	EPA tribal consultation (by teleconference) to discuss and receive comments on proposed screening criteria and screening process for alternatives. Tribal participants: Healy Lake, Minto, Northway, Tanana, and Tanacross. Also: Tanana Chiefs Conference and Yukon River Intertribal Watershed Council. Agency participants: EPA, ADNR, COE.
4/16/01	EPA hosted tribal G2G face-to-face meeting in Fairbanks with other permitting agencies to discuss (1) adequacy of baseline data, (2) screening evaluation criteria, (3) development of alternatives, (4) alternative screening process, (5) scoping responsiveness, and (6) elevation of authority within permitting agencies. Participating Tribes: Healy Lake, Dot Lake, Manley, Minto, Tanana, and Tanacross. Also: Tanana Chiefs Conference. Participating agencies: EPA, COE, ADNR, State Attorney General's Office, USFWS, ADFG, and ADEC.
4/16/01	Tribes met with Applicant to discuss issues of concern in Pogo Project Description document and ask questions/make proposals regarding tribal participation in operation of the proposed mine.
5/22/01	EPA Elevation of Authority letter issued delineating the process by which issues and concerns can and will be elevated beyond staff level if so requested by the Tribes.

Table 7.13-1 Pogo Mine EIS Process G2G Communications/Consultations

Date	Action
8/21 and 8/23/01	Healy Lake Tribal Council hosted three-day workshop in Tok, Dot Lake, and Fairbanks for EPA consultants and Native residents from throughout the upper Tanana region to identify cultural and subsistence resources and uses throughout the region.
9/24/01	EPA consultants interview tribal elder in Anchorage to obtain additional subsistence and cultural resources.
10/01	8-page EPA project status update mailed to all village residents summarizing tribal issues raised to date, requesting feedback, and offering contact information for agency decision-makers.
4/01 thru 4/02	Additional data gathered to (1) answer questions raised during the scoping process and (2) supplement baseline data as requested.
6/02	8-page EPA project status update mailed to all village residents describing Applicant's revised project description and EIS schedule, requesting feedback, and offering contact information for agency decision-makers.
8/23/02	EPA distributed copies of the Preliminary Draft EIS (PDEIS) to the 13 potentially affected Tribes for a five-week review and comment period.
9/02	EPA contacted Tribes to determine need for meeting to discuss PDEIS and Tribal Government comments, and if Tribes would like technical experts available to explain issues.
10/2/02	EPA hosted tribal G2G face-to-face meeting in Fairbanks with other permitting agencies to discuss the PDEIS and other tribal concerns. Participating Tribes: Healy Lake, Minto, Circle, Eagle, and Tanacross (by phone). Also: Tanana Chiefs Conference. Participating agencies: EPA, COE, ADNR, ADFG, and ADEC.
1/03	EPA contacted Tribes to determine whether they wish to review the draft NPDES permit. EPA provided Tribes with draft NPDES permit for review and comment.
3/14/03	DEIS distributed to the Tribes for 60-day comment period.
4/29 and 4/30	Public hearings on DEIS in Fairbanks and Delta Junction, hosted by EPA. ADNR, ADEC, ADFG, and COE participate.
4/30/03	EPA hosted tribal G2G face-to-face meeting in Fairbanks with other permitting agencies to discuss the DEIS and other Tribal concerns. Participating Tribes: Healy Lake, Minto, Nenana, and Dot Lake. Also: Tanana Chiefs Conference. Participating agencies: EPA, COE, ADNR, and ADFG.
9/19/03	Final EIS published and provided to the Tribes. Accompanying EPA and ADNR cover letter outlined the changes made between the DEIS and the FEIS, and offered to meet and discuss any concerns with the Tribes during the 30-day period after FEIS publication and prior to issuance of EPA's Record of Decision (ROD) and State of Alaska's final authorizations. Any input received from the Tribes will be considered in developing EPA's ROD and the State of Alaska's final authorizations.

Pogo Mine EIS Issues Raised During G2G Consultations

While G2G consultations were ongoing throughout the EIS process, issues raised by the Tribes may be categorized as those received during the scoping process, and those received following publication of the draft EIS.

Issues raised during scoping Following is a summary of concerns raised by the 13 potentially affected Tribes in the course of G2G consultations during the scoping phase of the Pogo Gold Mine EIS process. For ease of reference, individual comments have been grouped below under particular issues.

✦ **Water Quality**

- How the wastewater for 300 to 500 people is managed is of concern. If it is by leach field, then the field should be reclaimed when the mine is closed.
- Fuel tanks should be designed as dual walled and should allow for adequate bermed containment. (Existing design and management of fuel tank site at Pogo mine site is not adequate.)
- What will the mine do to the water?
- Cyanide levels in the water should be monitored to ensure that the maximum allowable discharge is not exceeded.
- We are concerned about the high levels of arsenic in the Pogo area and how the arsenic in the tailings might be hazardous.
- We are concerned about any chemicals or other threats to water quality and fish habitat that might affect the rest of the watershed.

✦ **Noise**

- What will the noise do to the animals? Our fear is that it will result in hearing loss to the animals that will not allow them to escape from predators. A research project in Delta Junction showed that birds of prey lost 30 percent of their hearing from sonic booms. We are requesting that the Air Force fly their new planes at 7,500 feet – as opposed to the old requirement of 5,000 feet.

✦ **Wetlands**

- Wetlands should be avoided in all of these new developments.

✦ **Socioeconomics**

- The pressures to form borough governments in our area need to be considered in this analysis insofar as the Mandatory Borough Formation Act will affect or be affected by this mining project and other development that might come with an all-season road.

✦ **Land Use**

- It would allow immediate access to timber sales according to George Mackie the University of Alaska Fairbanks Professor of Economics.
- The Pogo access road would result in uncontrollable access to new timber reserves.
- No matter which access alternative is selected, there will be increased timber harvests.
- We are concerned about what an all-season road will bring in terms of additional mines, logging, big game hunters and guiding, trappers.
- Once the road is in place, then people will move into the open tracts.
- History has shown us that a new road into an undeveloped area – even improvements to existing roads – opens the door for more and more development.
- The new mining prospects at Ogopogo will put even more pressure on our people.

- How do we protect against a general loss of wilderness? We want to preserve the pristine nature of Alaska – one of the last special places.

✦ **Subsistence Resource Impacts**

- Potential impacts to all game must be evaluated and minimized – especially migratory caribou, marten, and salmon.
- There is potential for accidental and inadvertent dumping of chemicals into waterways, thus affecting fish populations and health.
- Underground blasting in the project area could affect wildlife (e.g., physically damage the hearing of wildlife in the project area and/or frighten wildlife away from the project area).
- The Fortymile Caribou Herd population is on a large cycle – they are on the rebound – finally returning to their former range - so now is a vulnerable time to be considering this project. It is believed that a new road into the area may cause the herd to split again.
- There have already been changes in the caribou migration patterns – they used to come down to the airstrip at Pogo, but they are not any more.
- Do not affect John Healy trap line through the Clearwater Flats, or the trapping area on the lake, along the road; or the beaver trapping area near the house on Michigan Creek.
- Korean and Russian immigrants to Delta Junction are affecting our subsistence resources: the Koreans have fished out two lakes and the U.S. government is giving away homestead land to the Russians. Twenty-five relocated Russian families in Delta are eligible for state funding programs.
- Road access would allow for increased hunting pressure. Once outsiders get above the ridgeline, they'll be able to run the caribou along the ridge and then direct them to the soft snow in order to stop them. This could massacre the whole herd.
- Duck hunting by outsiders pushes game up into the high country.
- Trapping/small animal populations would be affected along a road.
- The caribou population will experience greater impacts than the moose.
- The possibility of an all-season road raises a concern for impacts to fish habitat.
- EPA needs to understand that the Healy Lake Tribe has a long tradition of sharing the rich subsistence resources in our area with other Tribes – so impacts to the Goodpaster drainage would affect more than just our Tribe.
- We live off of the land in Healy Lake – we hunt, fish, trap, cut wood. There is no welfare in our village.
- The road will keep animals away – especially the small animals. If the animals are gone, where are our children going to hunt and trap?
- Native foods are important to village life.

✦ **Cultural Resources**

- Our Native land uses need to be documented – especially historic sites, sacred sites and trapping areas.
- The Native people of Salcha should be consulted regarding potential impacts to Salchaket Tribe archeological resources.
- Do not overlook the historic and sacred sites at the Old Village of Goodpaster; these people were ancestors to Native peoples in Nenana, Old Nabesna Village, and Salchaket.
- A siting analysis should be done. What is the proposed site's relationship to our sacred sites, camping sites, and community sites?
- There are family secrets, sacred sites (such as burial sites), in many drainages – and we need to preserve the delicate balance between ensuring their preservation and divulging too much information, thus placing the sites at risk.
- The Luke Family has many burial sites in the area and they need to be consulted.

✦ **Access**

- We want the project to proceed, but we are adamantly opposed to an all-season road. The road would open up the back side of Native lands.
- An access road would open up the high country northeast of Healy Lake. This country is relatively easy terrain to travel once one makes it back that far, and it encompasses a relatively large area. It would seriously increase the hunting pressure on the area.
- The state could never control access once the road was built. The road would open up new areas to nonlocal and urban sport hunters. This hunting pressure would infringe on Athapaskan subsistence use areas. For example, it is not uncommon for Delta Junction residents to travel 50 miles by truck and then 20 miles by snowmachine to go trapping.
- Another example: the road to Rampart was put in by miners and it has been used by Fairbanks area residents for access. It has resulted in property damage and loss of wildlife.
- The Haul Road was just recently opened formally – but before that it could be used to get all the way to Deadhorse any time.
- Impacts that have resulted from the existing ice road to Healy Lake include theft of timber from Native lands, generation of garbage, property damage, and loss of wildlife.
- The development of new access infrastructure should be as limited as possible. Is there a real need for new airstrip if they are allowed to build an all-season road?
- An all-season road to Pogo would allow possible access into the Yukon Charlie River National Park and Preserve.
- If there is an all-season road, then certain restrictions should be in place. It should be patrolled, and access to the road should be restricted as stringently as access to the mine itself.

- Who will be allowed to use the access road is a tough issue for our villages; for example, Doyon has adjacent land that they wish to develop/mine.
- Once public funds are involved in the construction, maintenance, or even management of the road, then the state will be forced to open the road to public use.
- The state would not be able to control access if the road is built – regardless of intent.
- One Healy Lake resident summarized many of the above concerns above by saying (SRB&A, 2002a)

  "Our concerns are increased access, increased hunting pressure, increased population, less game, and increased trapping. Due to increased access, there will be a socioeconomic effect of increased population. Due to local hire jobs, non-Natives will come to the area. You cannot keep people from moving in to trap and hunt. An all-season road will mean roads encircle Healy Lake village. It will surround the village with modernization. The village will be in a 'bubble' with the Taylor Highway, the Alaska Highway, and the Pogo road. Once people can get into the high country, there is an ease of movement across the high country. Once there is a road to Pogo, a connection to Forty Mile District is imminent; it is only 26 miles. Roads will encircle the village. Healy Lake will be in the middle of a circle of roads. Roads beget roads. Roads beget more development."

✦ **Cumulative Impacts**

- Impacts to other users should be addressed in a cumulative impacts analysis.

✦ **EIS Process and Permit Issues**

- Many EIS process issues raised during G2G consultations have been addressed by the G2G communications/consultation plans and actions described earlier in this Section 7.13. The comments below raise legitimate concerns that have been, or may be, addressed in ongoing G2G consultations.
- How can we be assured that the issues that we raise in consultations with EPA are (1) integrated into the EIS/permitting process, and (2) shared with all of the other Tribes and tribal members in the potentially affected watershed?
- All of the downstream Tribes should be consulted – including Nenana, Manley, and Tanana.
- EPA should add the regional Fish and Game Advisory Boards to their research efforts – especially Tanana, Rampart, Manley, and Nenana; these people are very knowledgeable about subsistence resources.
- Government does not have a good track record for cleaning up the messes that are made by the Army or developers in the course of past projects. How can we be assured that this project will be different – that reclamation promises will be kept?
- What controls would be in place once the permits are issued?
- Who will be responsible for and be prepared to deal with the impacts associated with natural disasters at the mine site and downstream such as forest fires, earthquakes, floods, spring runoff?
- Bottom line: protect us.

✦ **Narrow Concerns**

The following concerns are narrow in scope. They either are discussed in the EIS section cited or are responded to in parentheses.

- Couldn't some of the mine facilities be built off-site – in already developed areas? Appendix A.1 (Options Screening)
- If the company disturbs merchantable timber in the course of building the road and/or mine site development, then they should be required to salvage that timber. (This is a permit, not EIS, issue. By policy, ADNR requires that all merchantable timber be purchased, cut, and removed from state lands.)

✦ **Miscellaneous**

The following expressed concerns are beyond the scope of this EIS.

- We are not against development, we just want to make sure that our health and safety are protected before development is allowed in our area.
- Canadian companies are notorious for tearing up the country.
- Why do they want to hurt Native People?

Issues raised following DEIS publication In addition to Tribal comments submitted at or following the public meetings, a government-to-government meeting was held in Fairbanks on April 30, 2003, with representatives of four potentially affected tribes and four federal and state agencies. Tribal representatives raised concerns and questions about several aspects of the proposed project as described in the draft EIS. By the nature of the meeting these questions and concerns were addressed at that time, and references were given to locations in the draft EIS where more detail could be found.

- How will the mine's water discharge affect fish?
- What will be the cultural impacts of the mine access road?
- How will caribou be affected?
- Will agencies seriously consider Tribal concerns?
- There will be impacts from the road on traditional subsistence use areas.
- The Healy Lake Traditional Council opposes any of the road being open to public use.
- What monitoring will be done by ADNR to control trespass on closed portions of the road?
- What will happen to the road after the mine closes.
- Where will wastewater discharge monitoring occur?
- Are there any benefits from the project for residents of Dot Lake and Healy Lake?
- Some tribal members have be working, or training for work, with the Pogo project.
- Applicant needs to get word out better about possible jobs and training.
- Are there any other local benefits other than jobs?
- The Applicant has been a good neighbor and helped in an emergency situation at Healy Lake.

- The Applicant has been working very closely and well with the community.
- What impact would the road have on wildlife?
- How many new hunters would use the road?
- Has there been an analysis of impacts if DOF were to build a road up Shaw Creek Valley?
- How much of the road would be reclaimed after mine closure?
- Are there any Native Alaskans with land in the Tanana Valley State Forest?
- How would the road be reclaimed?
- Can the Applicant's bond be renegotiated in the future?
- Will there be a domestic dump site a the mine?
- Has there been any consultation with the Tribes concerning waste disposal?
- What is the Applicant's position on road reclamation?
- Where have the DEIS public meetings been held?
- The applicant has actively tried to have local people on the project.
- It would be easier for village residents if these meetings were held in the villages.
- The Applicant has been in contact with the Tanana Chiefs Conference (TCC) employment department, and TCC is working with appropriate villages for employment opportunities.
- Appreciates the federal and state G2G consultation process.
- Rural economic development is very important to keep the villages viable.
- Would like to be able to comment on the road bridges after they are in place.
- Will there be an effort to inform Tribes not present about issues raised during this G2G meeting?
- How will the State treat the comments received during this G2G meeting?

Chapter 8 Consultation and Coordination

This chapter presents a description of EIS process coordination with Native Tribes, federal and state agencies, non-government organizations, and the public. References in this chapter to specific sections and appendices of this final EIS direct the reader to discussions providing greater detail on particular issues.

8.1 Scoping

On August 11, 2000, the Environmental Protection Agency (EPA) published a Notice of Intent (NOI) to prepare an EIS for the Pogo Mine Project in the *Federal Register*. On the same date, EPA distributed the *Scoping Document for the Pogo Mine Project Environmental Impact Statement* (EPA, 2000), which described the proposed project, the EIS process, and a document preparation schedule. Distribution of the scoping document began a 60-day public and agency review and comment period that ended on October 10, 2000. During this period, EPA invited the public and interested groups to provide information and guidance, suggest issues that should be examined, and express their concerns and opinions on all aspects (past, present, and future) of the proposed project.

EPA hosted two scoping open houses during that period. The first was held on September 26, 2000, in Delta Junction at the Delta Junction Community Center, and the second was held on September 27, 2000, in Fairbanks at the Noel Wien Library. Attendance was 46 and 50, respectively. These open houses served two purposes. One was to listen to and record the public's comments about the proposed project as described in the scoping document. The second was to respond to the public's requests for the background information and hands-on technical assistance that might be needed to fully understand the project description and proposed scope of the EIS analysis before commenting.

A "town meeting" format provided an opportunity for individuals to comment and promoted group interaction. All comments made during the open houses, whether oral or written on comment sheets or flipcharts, were documented as part of the official record. Although people were welcome to make comments and suggestions during the open houses, the record was specifically left open for an additional 13 days to accommodate anyone needing additional time to formulate comments.

Sixty-two sets of comments were received, excluding those received during government-to-government consultations. In five of these cases, individuals gave very similar comments on two or more occasions, usually orally and in writing. Thus, 57 individual sets of nontribal comments were received. Because some written comments were signed by more than one individual or organization, 64 entities actually commented.

On January 30, 2001, EPA distributed a 55-page *Pogo Mine EIS Scoping Responsiveness Summary* (EPA, 2001a). This document described the scoping process, and:

- Included 17 pages of representative public and agency comments as well as 4 pages of tribal comments
- Described how the comments were evaluated
- Listed the 17 issues identified by the scoping comments

- Identified the project's component options to address those issues
- Described how evaluation criteria were developed for the issues and how those criteria would be used to evaluate the component options and identify project alternatives to be analyzed in the EIS
- Discussed activities that would follow the scoping process and identified sources of information
- Presented an EIS / National Pollutant Discharge Elimination System (NPDES) permitting process and time line diagram
- Presented a Draft EIS (DEIS) Table of Contents

8.2 Government-to-Government Consultations

EPA undertook a concerted formal government-to-government consultation effort with 13 Alaska Native tribes potentially affected by the proposed project by virtue of their location (1) within a 125-mile radius of the proposed Pogo Mine site, or (2) within the potentially affected Tanana River watershed. The State of Alaska and the COE also participated in this consultation process. A detailed description of this consultation process is contained in Section 7.13 of this final EIS.

8.3 Federal Agency Consultation

The U.S. Army Corps of Engineers (COE) is a cooperating agency for this EIS and has been an active participant in all aspects of the EIS process. The U.S. Coast Guard, which has authority to issue construction permits for bridges across navigable waters, has been consulted concerning the proposed bridge across the Goodpaster River in the vicinity of the mine (Appendix D.1).

Pursuant to Section 7 of the Threatened or Endangered species Act (Section 7.6), EPA has consulted with both the U.S. Fish and Wildlife Serivce (USFWS) and the National Marine Fisheries Service (NMFS) (Appendix C.2). In addition, the USFWS provided review under the Bald Eagle Protection Act and the Migratory Bird Protection Act, and the NMFS was consulted concerning identification of essential fish habitat under the Magnuson-Stevens Fishery Conservation and Protection Act (Section 7.7, Appendix C.3).

8.4 State of Alaska Coordination

Because the Pogo Mine project is entirely on state land, the State of Alaska is a cooperating agency for this EIS and has been an active participant in all aspects of the EIS process. The Alaska Department of Natural Resources (ADNR), as land manager in the Pogo project area, is the lead state agency. In addition to ADNR, the Alaska Department of Transportation and Public Facilities (ADOT/PF), the Alaska Department of Environmental Conservation (ADEC), and the Alaska Department of Fish and Game (ADFG) have participated throughout the EIS process.

EPA as lead federal agency, and the COE as a cooperating agency, each participated in consultations with the State of Alaska Historic Preservation Office (SHPO) during the EIS process to ensure compliance with Section 106 of the National Historic Preservation Act (Section 7.5). As a result of these consultations, a programmatic agreement (PA) was developed that defines the procedures for considering historic properties with respect to entire agency programs, and formalizes the relationships between the various agencies responsible for Pogo project compliance with Section 106. This PA is contained in Appendix C.1 of this final EIS.

8.5 Non-Government Organizations

During the EIS process, the lead and cooperating agencies have maintained contacts and met with several non-government organizations concerned with the proposed action. The purpose of these contacts has been to provide information and obtain input concerning the project to maximize communications with these potentially affected entities.

The State of Alaska has been consulting with the Goodpaster Review Working Group. This group was created by the Tanana Basin Area Plan, the State of Alaska's land use plan for state lands in the Pogo project area, and consists of ten non-governmental organizations and the City of Delta Junction. ADNR is required to consult with this group on land management issues in the Pogo project area, and has been meeting with these groups to gather their input and to keep them informed about permitting and EIS activities.

8.6 Draft EIS Public Comments and Responses

The draft EIS comment period formally began with a notice of availability published in the *Federal Register* on March 14 , 2003, and closed 60 days later on May 13, 2003, although comments received after the closing date have been considered and responded to. In addition, public meetings during which comments and testimony were taken were conducted in Delta Junction on April 29, 2003, and in Fairbanks on April 30, 2003.

The 184 commenters made a total of approximately 641 comments. These figures do no include comments received during government-to government consultations discussed above. All public and agency comments, and responses to them, are contained in Appendix E of this final EIS.

Chapter 9 List of Major Permits and Authorizations

This chapter lists the major permits and authorizations that the Applicant would need to obtain for construction and operation of the Pogo Mine project.

9.1 Federal Permits

U.S. Environmental Protection Agency (EPA)

- Section 402 National Pollutant Discharge Elimination System (NPDES) Water Discharge Permit
- Section 404 Permit Review
- Spill Prevention, Control, and Countermeasure (SPCC) Plan
- Stormwater Construction and Operation Permit
- Underground Injection Control (UIC) Permit
- Section 106 Historical and Cultural Resources Protection
- Hazardous Waste Generator (Resource Conservation and Recovery Act [RCRA]) Identification Number

U.S. Army Corps of Engineers (COE)

- Section 404 Permit for Discharge of Dredge or Fill Materials into Waters of the U.S., including wetlands
- Section 106 Historical and Cultural Resources Protection

Mine Safety and Health Administration (MSHA)

- Mine Identification Number
- Notification of Legal Identity
- Miner Training and Retraining Plan Approval

Bureau of Alcohol, Tobacco, and Firearms (BATF)

- License to Transport Explosives
- Permit and License for Use of Explosives

Federal Communications Commission (FCC)

- Radio License

Federal Aviation Agency (FAA)

- Notice of Landing Area Proposal
- Notice of Controlled Firing Area for Blasting

U.S. Coast Guard (USCG)

- Construction Permit for a Bridge Across Navigable Waters

U.S. Department of Transportation (USDOT)

- Hazardous Materials Registration Number

9.2 State of Alaska Permits

Department of Natural Resources (ADNR)

- Plan of Operations Approval
- Upland Mining Lease
- Millsite Lease
- Lease of Other State lands
- Miscellaneous Land Use Permit
- Road Right of Way
- Joint Pipeline Office Approval
- Power Line Right of Way
- Certificate of Approval to Construct a Dam
- Certificate of Approval to Operate a Dam
- Temporary Water Use Permit
- Permit to Appropriate Water
- Material Sale
- Burn Permit
- Cultural Resources Authorizations
- Mining License
- Fish Habitat Permit
- Fish Passage Permit

Department of Environmental Conservation (ADEC)

- Certificate of Reasonable Assurance for Section 402 and 404 Permits
- Waste Disposal Permits
- Air Quality Control Permit to Construct and to Operate
- Air Quality Permit to Open Burn
- Approval to Construct and Operate a Public Water Supply System
- Plan Review for Non-Domestic Wastewater Treatment System

- Non-Domestic Wastewater Disposal Permit
- Plan Review and Construction Approval for Domestic Sewage System
- SPCC Plan Review Approval
- Oil Discharge Prevention and Contingency Plan (winter road option only)
- Storm Water Discharge Pollution Prevention Plan
- Food Sanitation Permit

Department of Transportation & Public Facilities (ADOT/PF)

- Driveway Permit

Department of Public Safety

- Approval to Transport Hazardous Materials
- Life and Fire Safety Plan Check
- Plan Review Certificate of Approval for each Building

Department of Labor and Workforce Development (ADOL)

- Certificate of Inspection for Fired and Unfired Pressure Vessel
- Employer Identification Number

Chapter 10 Index

Chapter 11 Glossary

Adit—A nearly horizontal passage from the surface in a mine.

Chert—A rock resembling flint and consisting essentially of a large amount of fibrous chalcedony with smaller amounts of cryptocrystalline quartz and amorphous silica.

CIL (or **carbon-in-leach**)—A method of recovering gold and other precious metals from pregnant cyanide solutions by adsorbing the precious metals onto activated carbon.

Clearing—Removal of vegetation above ground level, but with little or no disturbance to the vegetative mat on the ground surface.

Closed circuit—A loop in the milling process wherein a selected portion of the product of a machine is returned to the head of the machine for finishing to required specification. In a closed circuit, only material meeting specification is allowed to exit the loop. A common example would be a grinding mill in closed circuit with hydrocyclones.

Contact water—Water that comes into contact with areas disturbed during mine development or operation.

Country rock—Rock that is noneconomic, or has no mineral value, that surrounds the ore body (*c.f.* development rock).

Crusher—A machine that reduces (or crushes) material by compression. The machine consists of a movable conical head gyrating within an inverted concave cone. Material is crushed between the movable head and the bowl. The material is fed by gravity through the crusher.

Cyanide (CN)—A chemical compound of carbon (C) and nitrogen (N) used to dissolve gold and other precious metals. Typically, cyanide is delivered dry in the form of sodium cyanide (NaCN) briquettes and is dissolved in water to make a usable solution.

Cyanide process—That part of the milling process in which ore in the form of a slurry is exposed to a weak cyanide solution that dissolves gold and other precious metals.

Detritus—Accumulated material; debris; disintegrated or eroded matter.

Development rock—Rock that is noneconomic, or has no mineral value, that must be removed to allow access to the ore. Development rock can be used as fill in construction of roads, dams, and other mine facilities.

Dore—A metal alloy composed of gold and other precious metals. Typically the final product from a precious metals mine.

Exploration adit—Underground tunnel for access to an ore body.

Feasible—Capable of being carried out in a reasonably technical and economic manner.

Gravity circuit—A circuit with any of several devices that use the differences in specific gravity of materials to separate gold from other material.

Grizzly—Large stationary screen for sorting rock by size.

Laydown area—Uncovered gravel pad for storage of equipment and supplies.

Make-up water—Additional water added in the milling process to make up for water lost through evaporation, export with the tailings, and other means.

Mill—A facility in which ore is treated to recover valuable metals such as gold.

Milling—The process of separating the valuable constituents (gold) from the noneconomic constituents, which after milling are called tailings. Milling typically consists of crushing and grinding to liberate or free the gold, which then is recovered through a leach or gravity circuit.

Mining—The process of removing ore from the ground and transporting it to the mill. At Pogo, mining would include drilling, blasting, loading into trucks, and hauling to a primary crusher.

Mitigation—Avoiding, minimizing, rectifying, or reducing impacts.

Orographic effect— The distribution of precipitation with respect to topography and elevation.

Overburden—Nonmineralized material that overlies the ore body.

Polygon—A closed plane figure bounded by three or more line segments.

Portal—Surface opening of an underground tunnel.

Pulp—A suspension of pulverized or ground ore in water. The ore is kept in suspension by agitation and flow of the water.

Putrescible—Material that will decompose or rot.

Raise—A vertical shaft for venting air, moving ore, or emergency evacuation.

Refinery—That portion of the mill in which gold is purified by being melted with fluxes in a furnace and then poured into dore bars for shipment.

Saturated—The condition in which <u>all</u> openings in a rock or soil are filled with water.

Slurry—Same as "pulp."

Strip (or stripping)—A high-temperature and pressure process in which gold is removed from loaded carbon and placed back into solution.

Tailings—The finely ground material remaining after the gold has been extracted, the cyanide has been detoxified, and the pH has been neutralized.

Thickening—The partial separation of solids from liquid in a slurry by means of settling in a large tank. Typically, flocculants are added as a settling aid. Clarified water overflows from the top of the tank, and the thicker slurry exits from the bottom of the tank.

Toe—The bottom of a fill, such as a road embankment or dam.

Zero discharge—The standard of performance for protecting surface waters that requires containing all process fluids with no discharge outside the process circuit.

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