November 29, 2019

Via Electronic Delivery

Rob Potts
Project Lead
c/o USDA Forest Service
2221 N. Raguet St.
Lufkin, TX 75904

Re: Scoping Comments on National Forests and Grasslands of Texas Oil and Gas Leasing Analysis

Dear Mr. Potts:

We are writing to submit information for the U.S. Forest's Services consideration in its scoping of the Oil and Gas Leasing Analysis for the National Forests and Grasslands of Texas (NFGT). The Forest Service proposes to end the current moratorium on oil and gas leasing throughout its Texas planning area totaling 1.92 million acres, which is spread out over six non-contiguous management units, including the Angelina, Davy Crockett, Sabine, and Sam Houston national forests, and the Caddo and Lyndon B. Johnson national grasslands. Lifting the moratorium would open these public lands and adjacent areas to over 1,500 new hydraulic fracturing ("fracking") wells, and would result in clearing thousands of acres of forest habitat, harmful air pollution, and depletion and contamination of water resources, including public drinking water supplies such as Lake Conroe, Toledo Bend Lake, and Sam Rayburn Reservoir.

The U.S. Forest Service has never considered the impacts of fracking in its prior forest planning efforts. Accordingly, it is critical the Environmental Impact Statement (EIS) prepared by the Forest Service thoroughly examine the dangers and impacts of fracking and horizontal drilling. Indeed, in an earlier version of its Notice of Intent notifying the public of the scoping process, the Forest Service acknowledged the need to address these relatively new extraction techniques:

> Environmental impacts of oil and gas leasing were last evaluated in the 1996 Final EIS for the LRMP for the NFGT. That document did not include an analysis of current issues, such as greenhouse gas emissions and climate change, and technologies, such as horizontal drilling and hydraulic fracturing.
>
> More specifically, with respect to making lands on the NFGT available for oil and gas leasing, there is the need to address the following:

• Oil and gas development technology has changed since the forest plan was published. Technological changes in oil and gas extraction, such as hydrologic fracturing, have different water usage and disposal requirements, compared with conventional oil and gas development. There is a need to consider the impacts of these technological advances on surface and subsurface water and geologic resources.

• There is also the need to analyze the impacts of oil and gas leasing and development on air resources, based on current technologies, along with the need to address new greenhouse gas science and climate trends in the analysis and management direction.

• There is a need to analyze the impacts of the current oil and gas development technology on fish and wildlife resources and to provide oil and gas management direction, while maintaining species viability and diversity across the forest.[1]

Another issue that has never been considered in the U.S. Forest Service's prior oil and gas leasing analyses is the impact of fossil fuel production on climate change. A growing body of studies shows that to avoid the worst effects of climate change and stay within scientifically advised temperature limits, drastic and immediate cuts in greenhouse gas emissions are needed. Indeed, there is *no room for new fossil fuel extraction*, and even oil and gas production in currently operating fields must be phased out. Opening up new areas of public lands to oil and gas leasing and high-volume hydraulic fracturing or "fracking" would undermine efforts to reduce emissions to scientifically-advised limits. Attachment A (incorporated here by reference) contains a detailed analysis of the need to drastically and immediately reduce greenhouse gas emissions, phase out oil and gas production in existing fields, and avoid carbon "lock-in."

For reasons set forth in this letter, we urge the Forest Service to cease all new leasing of fossil fuels in the NFGT, including oil and natural gas. We also urge the Forest Service to prepare a full and thorough EIS that considers the significant unexamined impacts from the consequences of fossil fuel leasing. The EIS should consider a full range of alternatives, including: (1) an alternative that closes the entire planning area to oil and gas leasing; (2) an alternative that bans new hydraulic fracturing and other unconventional well stimulation activities, and requires strict controls on natural gas emissions and leakage; and (3) an alternative that bans all oil and gas activities, or at minimum fracking, beneath and around dams and reservoirs in the planning area, in light of new studies recommending these buffers. At a minimum, the Forest Service must consider alternatives that close substantial areas of the NFGT to oil and gas leasing, to comply with its duty under NEPA to analyze a "reasonable range of alternatives."

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[1] Dept. of Agriculture, Forest Service, National Forests and Grasslands in Texas; Oil and Gas Leasing Availability Analysis Environmental Impact Statement, [draft] Notice of intent to prepare an environmental impact statement (pre-publication version that was initially published online on August 26, 2019 but later replaced with a revised version).

A flash drive containing the references in this comment letter will be delivered to your office shortly via Federal Express delivery.

A. The EIS Must Satisfy the National Environmental Policy Act's ("NEPA") "Hard Look" Requirement

The National Environmental Policy Act is "our basic national charter for protection of the environment." 40 C.F.R. § 1500.1(a). Its twin aims are to facilitate informed agency decision-making and public access to information. By focusing both agency and public attention on the environmental effects of proposed actions, NEPA facilitates informed decision-making by agencies and fosters public participation. To accomplish these objectives, NEPA requires "responsible [federal] officials" to prepare an environmental impact statement ("EIS") to consider the effects of each "major Federal action[ ] significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C)(i).

The EIS must "provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment." 40 C.F.R. § 1502.1. An EIS must take a "hard look" at not only the direct impacts of a proposed action, but also the indirect and cumulative impacts. *See id.* § 1508.7, 1508.8; *N.M. ex rel. Richardson v. BLM*, 565 F.3d 683, 717 (10th Cir. 2009). Such analysis must include all reasonably foreseeable impacts of the proposed action. An EIS must also include a discussion of possible mitigation measures to avoid adverse environmental impacts. *See* 42 U.S.C. § 4332(C)(ii); 40 C.F.R. §§ 1502.14(f), 1502.16(h), 1508.14, 1508.25(b)(3). To "properly evaluate the severity of the adverse effects" of a proposed project, the discussion of mitigation measures must be "reasonably complete."

NEPA's implementing regulations require that the agency "shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions," and shall ensure the scientific accuracy and integrity of environmental analysis. *Id.* § 1502.24. The agency must disclose if information is incomplete or unavailable and explain "the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts." *Id.* § 1502.22(b)(1). The agency must also directly and explicitly respond to dissenting scientific opinion. *Id.* § 1502.9(b). The EIS must also be circulated for public comment.

Federal agencies must comply with NEPA before there are "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." 42 U.S.C. § 4332(2)(C)(v); *see also* 40 C.F.R. §§ 1501.2, 1502.5(a). Oil and gas leasing is an "irreversible and irretrievable" commitment of resources. *N.M. ex rel. Richardson*, 565 F.3d at 718.

NEPA requires agencies to consider "any adverse environmental effects which cannot be avoided." 42 U.S.C. § 4332(2)(C)(ii). In so doing, agencies must "identify and develop methods and procedures . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations." *Id*. § 4332(2)(B).

The Forest Service must strictly follow NEPA's procedural requirements to ensure the decisionmakers and public are properly apprised of the environmental impacts of its proposed action to reopen the NFGT to oil and gas leasing. In addition, to the extent the Bureau of Land Management (BLM) intends to rely on the Forest Service's EIS and planning process for its decisions to offer lands in the NFGT for oil and gas leasing, the BLM must cooperate in the EIS's preparation, independently review the EIS's adequacy, and comply with all applicable requirements under the Federal Land Policy and Management Act.

B. The EIS Must Take a Hard Look at the Impacts on Water Resources

Fracking in the NFGT would put sensitive water resources at risk. Fracking a single well requires millions of gallons of water.[2] The large amount of water used for fracking is stressing water levels in areas where water use has been traditionally low, such as rural counties in Texas.[3] Construction of well pads and pipelines, spills and leaks, and the fracking process itself, and water contamination also pose threats to groundwater and surface water quality.

1. Water Quality

Oil and gas development has significant potential to contaminate groundwater and surface water in the planning area and surrounding regions. Contamination happens through numerous pathways including: (1) spills, leaks, and transportation accidents; (2) during the fracking process due to well malfunctions, migration of fracking fluids or fluids from the fractured formation to aquifers, and mobilization of subsurface materials to aquifers; (3) during flowback due to releases, leakage of on-site storage, and spills from pits (caused by improper construction, maintenance, or closure); and (4) during wastewater disposal due to injection of wastewater into groundwater, incomplete treatment, and transportation accidents.[4] The Forest Service must disclose and analyze each of these risks of water contamination on local water resources in the planning area and the significance of these threats.

The proximity of oil and gas wells in the planning area to drinking water sources such as Lake Conroe, Toledo Bend Lake, and Sam Rayburn Reservoir is of significant concern. Lake Conroe supplies water to the City of Houston, the Woodlands, and other local communities in County. Sam Rayburn Reservoir is also a drinking water supply to surrounding communities.

[2] The Academy of Medicine, Engineering and Science of Texas, Environmental and Community Impacts of Shale Development in Texas, 44 (2017) ("Texas Shale Report"), *available at:* http://tamest.org/wp-content/uploads/2017/07/Final-Shale-Task-Force-Report.pdf.

[3] *Id.*

[4] Vengosh, A. et al., A critical review of the risks to water resources from unconventional shale development and hydraulic fracturing in the United States, 48 Environmental Science and Technology 8334 (2014); Burton, Taylour G. et al., Elucidating hydraulic fracturing impacts on groundwater quality using a regional geospatial statistical modeling approach, 545 Science of Total Environment 114 (2016); DiGiulio, D.C. & R.B. Jackson, Impact to underground sources of drinking water and domestic wells from production well stimulation and completion practices in Pavillion, Wyoming, Field, 50 Environmental Science and Technology 4524 (2016); Cahill, Aaron G. et al., Mobility and persistence of methane in groundwater in a controlled-release field experiment, 10 Nature Geoscience 289 (2017); Texas Shale Report at 127.

Toledo Bend Lake supplies water to City of Mansfield,[5] De Soto Parish Water Works District #1 (serving De Soto Parish),[6] City of Many Water System, Pendleton Water Association, and the South Toledo Bend Water District (serving Sabine Parish).[7]

According to the EPA, between 2000 and 2013, about 3,900 public water systems were estimated to have had at least one fracked well in one mile of their water source. These public water systems served more than 8.6 million people year-round in 2013. Another 3.6 million people were estimated to have gotten drinking water from non-public water supply wells with at least one fracked well.[8] This is of great concern given the harmful chemicals found associated with fracking.

Many toxic chemicals used in fracking and oil and gas extraction are water soluble and pose a threat to the water we drink. For example, hydrochloric acid is used to initiate rock fractures, ethylene glycol is used to prevent scale deposits in pipes, and glutaraldehyde is used to eliminate bacteria from produced water.[9] There are also chemicals that are directly associated with fossil fuels and produced water, such as the BTEX chemicals. This suite of chemicals, both from fracking fluids and fossil fuels, poses threats to virtually all systems of the body including the sensory, gastrointestinal, immune, reproductive, cardiovascular, endocrine, and nervous systems.[10]

These chemicals can be mobilized in a number of ways, one of which is spills. Several studies have noted spills of fracking fluids or additives, most of which were caused by equipment failure or human error. For instance, an EPA analysis characterized 151 spills of fracking fluids or additives on or near well sites in 11 states between January 2006 and April 2012. Of the total, 34% of the spills were due to equipment failure, 25% were due to human error, and more than 30% of the spills were from fluid storage units.[11] Similarly, in a study of spills reported to the Colorado Oil and Gas Conservation Commission, of 125 spills during well stimulation between January 2010 and August 2013, 51% were caused by human error, and 46% were caused by equipment failure. Furthermore, of the 151 spills analyzed by the EPA, the spill amount ranged

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[5] City of Mansfield, Louisiana, Toledo Bend Water Treatment Plant, http://www.cityofmansfield.net/police/public_works/toledo_bend_water_treatment_plant.html/.
[6] USGS, Water Resources of De Soto Parish, Louisiana, Fact Sheet 2013-3107 (May 2014), available at https://pubs.usgs.gov/fs/2013/3107/pdf/fs2013-3107.pdf.
[7] South Toledo Bend Water District, Plant Fact Sheet, available at http://toledo-bend.net/stbwd/facts.asp; History of South Toledo Bend Waterworks, http://toledo-bend.net/stbwd/history.asp; *See also* Caldwell, Peter et al., USDA Forest Srevice, Southern Research Station, Quantifying the role of National Forest system lands in providing surface drinking water supply for the Southern United States (2014) at 115, available at https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs197/gtr_srs197.pdf (listing public water system intakes receiving water from Sabine National Forest); Louisiana Department of Natural Resources, Toledo Bend Current Water Sales (2012), available at http://www.dnr.louisiana.gov/assets/docs/conservation/groundwater/Appendix_J1.pdf
[8] U.S. EPA, Hydraulic fracturing for oil and gas: impacts from the hydraulic fracturing water cycle on drinking water resources in the United States (Final Report). U.S. Environmental Protection Agency, Washington DC, USA (2016)("EPA 2016 HF Study"), p. ES-8.
[9] California Council on Science and Technology, Advanced Well Stimulation Technologies in California (2016) ("CCST 2016"), *available at:* http://ccst.us/publications/2014/160708-blm-report.pdf at 381.
[10] Yost, Erin et al., Estimating the Potential Toxicity of Chemicals Associated with Hydraulic Fracturing Operations Using Quantitative Structure-Activity Relationship Modeling, 50 Environmental Science and Technology 14 (2016).
[11] EPA 2016 HF Study, p. ES-22.

from 5 gallons up to 19,320 gallons. Thirteen of the 151 spills reached a surface water body, with the largest spill volume reported reaching a water body being 7,350 gallons.[12] Also reported were spills reaching Pennsylvania surface waters between January 2008 and June 2013 with volumes ranging from 3,400 gallons to 227,000 gallons.[13] Such noted mobility of spill waters ultimately poses a threat to both surface and ground beneficial use waters. Similar threats are posed by spills of produced water as well.

Another way in which chemicals can be mobilized is through unintended flow pathways in the subsurface resulting from fracking. A well with insufficient mechanical integrity (e.g. due to well casing and tubing leaks, uncemented annulus, gaps in cement, gaps between casing and cement) can allow unintended fluid movement. Also, the fracture network produced during fracking could intersect sources of groundwater or surface water constituting a conduit for fracking water to flow. Finally, there have been instances where fracking one well has affected a nearby oil and gas well or its fracture network, resulting in spills of the nearby well.[14]

Perhaps the best examples of unwanted fluid migration are found in Pennsylvania. For example, an abandoned well in Pennsylvania produced a 30-foot geyser of brine and gas for more than a week after the fracking of a nearby gas well.[15] In another example, in 2009, shortly after drilling and fracking in the Marcellus Shale, residents near the township of Dimock, Pennsylvania reported that natural gas was appearing or increasing in their water wells.[16] As of 2016, over 1,000 fracking water contamination complaints had been filed from 17 of 40 fracking counties in Pennsylvania.[17] However, evidence of fluid migration has been observed in many other settings, including the Raton Basin of Colorado and Parker County, Texas, posing risks to drinking water and ultimately public health.[18]

The EIS must analyze the risk of water contamination via old, leaking oil and gas wells in reservoirs, such as Lake Conroe and Toledo Bend Lake, via fracking beneath or near them. New fractures created by fracking could create new pathways of communication between new wells and old wells. If toxic fracking chemicals migrate from a new well to an old well, those chemicals could then leak into the lake.

Another concern is the increasing problem of uncontrolled fractures created by hydraulic fracturing operations causing "frack hits"—"an unplanned surge of pressurized fluid into another well, often resulting in surface spills" and causing damage to the well.[19] Recently, a jury awarded damages to a vertical well owner whose well was damaged by a frack hit caused by horizontal well fracking operations; the high-pressured fracking fluid shot past the area where production was to occur, and toward the vertical well's production area, and the day after, frack fluid started

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[12] *Id.* at ES-23.
[13] *Id.* at ES-24.
[14] EPA 2016 HF Study.
[15] *Id.* at ES-32.
[16] EPA 2016 HF Study, p. 6-11.
[17] Peltier, Laurel, Pennsylvania Fracking Water Contamination Much Higher Than Reported. EcoWatch, February 4, 2016. https://www.ecowatch.com/pennsylvania-fracking-water-contamination-much-higher-than-reported-1882166816.html. (Accessed July 12, 2018).
[18] EPA 2016 HF Study, p. ES-45.
[19] Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands, 80 Fed. Reg. 16128-01 (March 26, 2015).

erupting from the well into the air.[20] Numerous similar lawsuits have been filed against horizontal well operators.[21] The defendant claimed that it could not be held liable, because the fractures created by fracking were too hard to control, and cited a previous ruling noting that such fractures are "of immeasurable length and uncontrollable direction."[22] Regardless of whether the defendant was to blame, it is evident that frack hits are an inherent risk of horizontal drilling operations.

Increased fracking activities could also threaten groundwater. A recent study focused on the southern Eagle Ford Shale region found evidence of "episodic contamination events potentially attributed to unconventional oil and gas development or other anthropogenic activities." [23] Elevated levels of bromide were detected in groundwater, along with multiple volatile organic compounds and dissolved gas effervescence, suggesting contamination by unconventional oil and gas activities. Further, a study of 18 wells drilled in south Texas between 1990 and 2011; found 61 percent had well integrity or barrier failures mainly in shale zones.[24]

In another study of groundwater in the Permian Basin, researchers monitored water quality in 42 private water wells over a 13-month period in three contiguous counties as unconventional oil and gas activities increased within the area.[25] Over time, the researchers found significant changes in total organic carbon and pH and ephemeral detections of ethanol, bromide, dichloromethane, and multiple volatile organic compounds after the initial sample phase. Detections of metal ions including barium, iron, selenium, and strontium also fluctuated over the 13-month period.[26] The paper noted a potential link between the contamination and unconventional oil and gas development, and that the most likely mechanism would be physical degradation of the protective casing in the vertical segments of fracked wells—a phenomenon observed in the Barnett and Marcellus shales.[27] Additionally, the accumulation of bromide and alcohol species "indicates that there may be longer standing residual changes in groundwater chemistry that can persist in regions engaged in unconventional oil and gas development."[28]

The EIS must not just disclose the particular pathways for water contamination but also disclose the potential severity of these effects on sensitive and scare water resources. The

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[20] Soraghan, Mike, Small producer wins verdict against Devon in 'frack hit' case, E&E News, Aug. 17, 2017, *available at:* https://www.eenews.net/energywire/2017/08/17/stories/1060058877.
[21] *Id*.
[22] *Id*.; *see also* H&S Equipment, Inc. v. Devon Energy Production Co., Case No. Civ-15-12440HE, Defs.' Mot. for Summary Judgment, 23 (W.D.Okla. March 15, 2017) (Dkt. 35) (citing *Coastal Oil & Gas Corp. v. Garza Energy Tr.*, 268 S.W.3d 1, 7, 32 (Tex. 2008)); *Coastal Oil*, 268 S.W.3d at 7 ("Estimates of [fracture] distances are dependent on available data and are at best imprecise. Clues about the direction in which fractures are likely to run horizontally from the well may be derived from seismic and other data, but virtually nothing can be done to control that direction…").
[23] Hildenbrand, Z.L., et al., A reconnaissance analysis of groundwater quality in the Eagle Ford shale region reveals two distinct bromide/chloride populations, Science of the Total Environment, 575 (2017) 672-680.
[24] Davies, Richard, Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation, Marine and Petroleum Geology, vol. 58 available at http://www.sciencedirect.com/science/article/pii/S0264817214000609.
[25] Hildenbrand, Z.L., et al. Temporal variation in groundwater quality in the Permian Basin of Texas, a region of increasing unconventional oil and gas development, Science of the Total Environment, 562 (2016) 906-913.
[26] *Id*. at 912.
[27] *Id*.
[28] *Id*.

potential consequences of a spill or leak could be severe and long-lasting. For example, in 2017, EPA officials shut down seven wastewater injection wells in Oklahoma, linking them to contamination of a creek that caused a fish kill, extremely high salt levels, and water temperatures of nearly 100 degrees in some parts of the creek.[29] Contamination likely resulted from mechanical failures and could encompass a wider area than is presently known.[30] Despite finding continued pollution of the creek since August 2016, EPA did not order the shut-down until almost one year later, and after having conducted at least 20 inspections of the site. The extremely delayed response raises serious questions over the sufficiency of regulatory oversight to prevent significant impacts to the environment. Moreover, here, catastrophic consequences such as the contamination of a number of communities' drinking water sources. The added risk to municipal water supplies is a significant factor that must be taken into account.

Leaky wells can have severe and life-threatening consequences. In 2014, a water well exploded in Palo Pinto County, Texas due to the presence of thermogenic gas originating from deep layers targeted by oil and gas operators.[31] The explosion injured a rancher, his father, and his daughter.

2. Water Quantity

The RFDS projects that 1.7 billion gallons of water will be used to frack oil and gas wells on federal surface; 5.3 billion gallons will be used to frack oil and gas wells within the national forest boundary; and 8 billion gallons of water will be used to frack oil and gas wells in an area that includes both the lands within the national forest boundary and a 1.5 mile buffer outside the forest boundary.[32] It is unclear whether these projections also account for water needed for drilling, dust abatement, and other activities, and not just fracking.

The EIS must address the full scope of water use for oil and gas development in the NFGT and its direct, indirect, and cumulative impacts on local surface and groundwater water resources, including the water supply of surrounding communities; recreation, such as boating and fishing; and fish and wildlife that depend on lakes and streams. It must also use the best available information on per well fracking water use in the relevant shale plays and disclose how the numbers for horizontal fracking operations and other fracking operations were derived. In recent years, the oil industry has been rapidly increasing its per-well water usage for fracking. Between 2011 and 2016, there was a 770% increase in water use per well for fracking and wastewater production.[33]

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[29] Soraghan, Mike, EPA Orders 3 companies to shut wells in Okla., E&E News, Aug. 10, 2017, *available at*: https://www.eenews.net/stories/1060058609.
[30] *Id*.
[31] Soraghan, Mike, A flash fire, third-degree burns and an investigation without end, E&ENews (June 1, 2016), available at http://www.eenews.net/stories/1060038097; Soraghan, Mike, Experts link gas well to explosion that injured family, E&ENews (Feb. 14, 2017), available at http://www.eenews.net/energywire/2017/02/14/stories/1060049835.
[32] RFDS at 3.
[33] Kondash, Andrew J. et al., The intensification of the water footprint of hydraulic fracturing, 4 Science Advances 1(2018).

The EIS must discuss the impact of fracking on water quantity in local streams and aquifers, in light of water scarcity throughout the planning region. In doing so, the EIS must disclose the rate of water depletion for fracking activities in localized areas where fracking is likely to occur (e.g., a single forest unit or watershed), rather than simply disclose aggregate water use throughout the entire planning area.

High levels of water depletion are unsustainable, especially as climate change-driven water scarcity threatens and stresses surface and groundwater sources across Texas.[34] Water used in large quantities may lead to several kinds of harmful environmental impacts. Removing water for fracking and other oil and gas development can stress existing water supplies by lowering water tables and dewatering aquifers, decreasing stream flows, and reducing water in surface reservoirs.[35] This can result in changes to water quality and the hydrology of water systems, and it can increase concentrations of pollutants in the water. There is potential for the reductions in water quantity to impact aquatic and riverine species and habitat by affecting water flows and natural river processes: this, in turn, could lead to fish declines, changes to riparian plant communities, and alterations to sediment.

For example, increasing water use from fracking in Montgomery County could reduce both Lake Conroe and groundwater water supplies. Montgomery County is already under stress from increasing demand for groundwater, which has led to ground subsidence and risks of seawater inundation during storm surges (which may worsen with more severe storms due to climate change).[36] Increased water demand could also result in lower water levels in Lake Conroe, reducing property values and impacting recreation in the lake.[37]

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[34] Kuchment, Anna, Climate change to bring North Texas longer droughts, heavy rains, 120-degree temps within 25 years, Dallas Morning News (Nov. 28, 2018), https://www.dallasnews.com/news/environment/2018/11/28/climate-change-to-bring-north-texas-longer-droughts-heavy-rains-120-degree-temps-within-25-years/; EPA, Case Study: Water and Wastewater Utilities Planning for Climate Change City of Houston, Texas (2015), https://nepis.epa.gov/Exe/ZyNET.exe/P100SHW4.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2011+Thru+2015&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C11thru15%5CTxt%5C00000027%5CP100SHW4.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL#; Satija, Neena, Water Planners Focus on a More Populous Texas, but Not a Hotter One, Texas Tribune (July 14, 2014), https://www.texastribune.org/2014/07/14/state-only-planning-bigger-texas-not-hotter-one/.

[35] *Id.* at 60.

[36] Cotelesse, Chris, Montgomery County Is Outgrowing its Water Supply, Houston Chronicle (June 25, 2013), https://www.chron.com/neighborhood/woodlands/news/article/Montgomery-County-is-outgrowing-its-water-supply-9535098.php; Lone Star Groundwater Conservation District, Subsidence, https://www.lonestargcd.org/subsidence; Turco, Michael, THE PAST, PRESENT, AND FUTURE OF SUBSIDENCE IN THE HOUSTON REGION, https://lonestargcd.squarespace.com/s/ghsozs337vfx2274uz181kp1yk76yy.

[37] Schafler, Kelly, Lake Conroe area residents, officials express concern over proposal to seasonally lower lake level, Community Impact Newspaper (June 22, 2018), https://communityimpact.com/houston/environment/2018/06/22/sjra-proposes-lake-conroe-to-be-lowered-seasonally-as-a-flood-mitigation-strategy/; Rogers, George Oliver, Impact of Lake-Level Reductions on Lake

3. EPA Study on Impacts of Fracking on Drinking Water Resources

In 2016 the EPA completed its study on the impacts of fracking on drinking water resources, which found scientific evidence that hydraulic fracturing activities can and has impacted drinking water resources.[38] The report identifies certain conditions under which impacts from hydraulic fracturing activities can be more frequent or severe.[39] The EPA identified a number of risk factors that may increase the risks of drinking water depletion and contamination, all of which are present with respect to the potential for increased fracking in the planning area:

- **Risk factor 1:** Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources.

  Fracking requires enormous water depletions, which could result in severe impacts on local water resources in the arid and drought-prone environment of Texas. In Texas, groundwater use is not regulated, unless a local groundwater conservation district exists for the county.[40] The EIS must address the extent to which surface and groundwater impacts would be controlled by local planning and regulation, or the extent to which the Forest Service would regulate water use.

- **Risk factor 2:** Spills during the handling of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources.

  Large volumes of chemicals and wastewater are used and produced in the completion of horizontal wells in the Eagle Ford Shale.[41] In 2015 2,700 spills occurred at oil and gas sites in Texas, though this figure may vastly underestimate spills, as the state does not track wastewater spills.[42] Spills affecting groundwater or surface water in 2015 totaled 124 and 92 spills in Texas and Oklahoma, respectively.[43] Texas officials found 50 cases of groundwater contamination caused by oil and gas operations throughout the state that

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Conroe Area: Lake Area Property Values, Property Tax Revenues and Sales Tax Revenues (July 2012), https://hrrc.arch.tamu.edu/_common/documents/Lake%20Conroe%20Final%20Report.pdf.

[38] U.S. Environmental Protection Agency, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (2016) ("USEPA 2016").

[39] *See id.* at ES-3.

[40] TCEQ, Groundwater Regulation for Private Well Owners, avaihttps://www.tceq.texas.gov/response/drought/groundwater_regulation.html.

[40] Environment America, Fracking By the Numbers ("Environment America Report"), 13 (2016), available at https://environmentamerica.org/sites/environment/files/reports/Fracking%20by%20the%20Numbers%20vUS.pdf.

[41] U.S. Bureau of Reclamation, [Draft Final] Best Management Practices: Hydrocarbon Exploration, Development, and Production at Nueces River Project, Choke Canyon Reservoir, Texas, 2-8 - 2-9 (Aug. 2015) ("BoR Study").

[42] Soraghan, Mike, In Texas wastewater spills get less scrutiny, E&ENews (Aug. 2, 2016), available at http://www.eenews.net/energywire/stories/1060041056.

[43] Soraghan, Mike & Pamela King, Driling mishaps damage water in hundreds of cases, E&ENews (Aug. 8, 2016), available at http://www.eenews.net/energywire/stories/1060041279/.

year.[44] Spills occurred at oil and gas wells, waste disposal sites, and gas plants, and along pipelines.

- **Risk factor 3:** Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources.

  Studies show that well casing failures are a chronic problem regardless of whether wells are old or new, fracked or not fracked.[45] For example:

  > A ProPublica review of well records, case histories and government summaries of more than 220,000 well inspections found that structural failures inside injection wells are routine. From late 2007 to late 2010, one well integrity violation was issued for every six deep injection wells examined — more than 17,000 violations nationally. More than 7,000 wells showed signs that their walls were leaking. Records also show wells are frequently operated in violation of safety regulations and under conditions that greatly increase the risk of fluid leakage and the threat of water contamination.[46]

  In a study of 18 wells drilled in south Texas between 1990 and 2011, 61 percent had well integrity or barrier failures mainly in shale zones.[47]

  Hundreds of thousands of Texas' oil and gas wells have not been inspected for five years due to a severe shortage of inspectors, increasing the risk of leaks and spills.[48] Just 158 inspectors are currently responsible for monitoring 435,000 wells, according to the Texas Railroad Commission.[49]

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[44] Soraghan, Mike, Texas officials found 50 cases of groundwater contamination in 2015, E&ENews (Sept. 6, 2016), available at http://www.eenews.net/energywire/stories/1060042314/; TCEQ, Joint Groundwater Monitoring and Contamination Report—2015 (June 2016), available at https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/056-15.pdf.

[45] Johnson, R. et al., The Environmental Costs and Benefits of Fracking, Annu. Rev. Environ. Resour. 2014. 39:7.1-7.36 (see pp. 7.11-7.14 for discussion of well failure rates); Johnson, Robert B., The integrity of oil and gas wells, 111 Proceedings of the National Academy of Science 1092 (2014), available at http://www.pnas.org/content/111/30/10902; Ingraffea, A., Fluid Migration Mechanisms Due to Faulty Well Desgin and/or Construction: An Overview and Recent Experiences in the Pennsylvania Marcellus Play, Physicians Scientists & Engineers for Healthy Energy (Oct. 2012) (noting casing failures are "not rare" in the oil and gas industry"); Environment America Report at 11 (noting data from fracking wells in Pennsylvania from 2010 to 2012 show a 6 to 7 percent rate of well failure due to compromised structural integrity).

[46] Lustgarten, Alexander, Are Fracking Wastewater Wells Poisoning Groundwater Beneath Our Feet?, Scientific American (June 2012), available at https://www.scientificamerican.com/article/are-fracking-wastewater-wells-poisoning-ground-beneath-our-feeth/.

[47] Davies, Richard, Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation, Marine and Petroleum Geology, vol. 58 available at http://www.sciencedirect.com/science/article/pii/S0264817214000609.

[48] Handy, Ryan Maye, Shortage of inspectors leaves thousands of oil, gas wells unmonitored, Houston Chronicle (Feb. 8, 2017), available at https://www.houstonchronicle.com/business/article/Shortage-of-inspectors-leaves-thousands-of-wells-10913787.php.

[49] *Id*.

- **Risk factor 4:** Injection of hydraulic fracturing fluids directly into groundwater resources.

  Injection of wastewater into protected aquifers is highly problematic in Texas. The Texas Railroad Commission does not have any handle on which aquifers in Texas are a protected drinking water sources under the Safe Drinking Water Act, and has never issued a single aquifer exemption for oil and gas wastewater injection into a protected aquifer. [50] This has likely resulted in injection of wastewaters into protected drinking water sources and contamination of those aquifers. This is illegal activity that is likely to result from oil and gas activity in Texas, and is per se significant under NEPA.

  While Texas requires the disclosure of chemicals used in fracking fluids, exceptions are allowed if the disclosure would reveal confidential business information.[51] Thus, there is great uncertainty regarding the identity and impacts of fluids injected into drinking water resources.

- **Risk factor 5:** Discharge of inadequately treated hydraulic fracturing wastewater to surface water.

  Texas allows discharge of wastewaters into surface waters, and there have been incidents of intentional dumping of wastewaters in Texas and Oklahoma.[52]

- **Risk factor 6:** Disposal or storage of hydraulic fracturing wastewater in unlined pits resulting in contamination of groundwater resources.

  It is unclear the extent to which liners are currently required for pits used in oil and gas operations. BLM Onshore Order No. 7 allows unlined produced water pits under certain circumstances, and it is unclear whether unlined pits would be allowed even if naturally occurring radioactive materials were present in the produced waters to be disposed.[53] If surface activities occurred on private surface rather than federal surface, it is unclear the

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[50] Clean Water Action, Texas Aquifer Exemptions: Ignoring Federal Law to Fast Track Oil & Gas Drilling (2016), available at https://www.cleanwateraction.org/sites/default/files/docs/publications/Texas%20Aquifer%20Exemptions%20-%20Clean%20Water%20Action%20August%202016.pdf.

[51] Carroll, Susan, Texas law shields companies from disclosing fracking chemicals, San Antonio Express, (Feb. 7, 2016), https://www.expressnews.com/news/local/article/Texas-law-shields-companies-from-disclosing-6813995.php.

[52] Richardson, Nathan et al., State of State Shale Gas Regulation, at 55 (May 1, 2013), available at https://www.rff.org/publications/reports/the-state-of-state-shale-gas-regulation/; Reuters, Illegal dumping of fracking fluids in Texas highlights risk (May, 21 2014), available at https://www.rt.com/usa/160604-texas-fracking-wastewater-dumping/; Mulder, Brandon, Painter: Illegal wastewater dumping continues throughout county (July 12, 2015), available at http://www.mrt.com/business/energy/article/Painter-Illegal-wastewater-dumping-continues-7410735.php; Terry-Cobo, Sarah, Wastewater Watching in Oklahoma: Illegal Dumping Poses Problems for Oil Companies, Public, The Journal Record (July 27, 2012), available at https://www.questia.com/newspaper/1P2-33557408/waste-watching-in-oklahoma-illegal-dumping-poses.

[53] *See* BLM, Onshore Order No. 7, § III.D.2.a, available at https://www.blm.gov/wy/st/en/programs/energy/Oil_and_Gas/docs/onshore_order_7.html.

extent to which liners for pits would be required. In Texas, unlined pits are allowed.[54] The Forest Service should prohibit the use of unlined pits in connection with the development of federal minerals.

The EIS must address and analyze these risk factors unique to oil and gas activities in the planning area.

C. The EIS Must Analyze the Air Quality and Public Health Impacts of Fracking

The Forest Service must take a hard look at the air quality and public health impacts from future oil and gas development in the planning area. Oil and gas operations emit numerous air pollutants, including volatile organic compounds (VOCs), NOX, particulate matter, hydrogen sulfide, and methane. Fracking operations are particularly harmful, emitting especially large amounts of pollution, including toxic air pollutants. Permitting fracking and other well stimulation techniques will greatly increase the release of harmful air emissions around areas in East and North Texas that are struggling to meet basic national air quality standards. The Forest Service must analyze air quality impacts from induced oil and gas development in conjunction with the existing air quality landscape for the Forest Plan, using monitoring data for criteria pollutants under the federal Clean Air Act, and in connection with past, present, and future private and federal development. This analysis must also evaluate impacts on the Houston and Dallas metro area ozone non-attainment areas, which abut the National Forest and Grasslands in the planning area.[55]

Forecasting cumulative air quality impacts from the leasing and resource management of fossil fuel development is required by well-established law. *WildEarth Guardians v. United States Office of Surface Mining Reclamation & Enforcement*, 104 F. Supp. 3d 1208, 1227-1228 (D. Colo. 2015). Moreover, interagency guidance recommends that, for NEPA analysis supporting oil and gas leasing, a lead agency should conduct an emissions inventory of criteria pollutants based on a reasonably foreseeable development scenario projecting the total number of wells that could be developed in the planning area, and air modeling if certain criteria are met.[56]

Given the likelihood that fracking and other similarly harmful techniques would be employed in the exploration and development of the lease parcels, the Forest Service has an obligation to analyze and disclose the reasonably foreseeable development scenario of horizontal shale wells for the planning area; an inventory and modeling of all reasonably foreseeable emissions from this development scenario, including criteria pollutants and hazardous air pollutants; and health impacts of these emission levels on affected communities. The Forest Service must also identify environmental impact mitigation methods for controlling air pollution

[54] Texas RRC, Eagle Ford FAQs, available at http://www.rrc.state.tx.us/about-us/resource-center/faqs/oil-gas-faqs/faq-eagle-ford/.
[55] U.S. Dept. of Agriculture, U.S. Forest Service, Texas National Forests and Grasslands, Oil and Gas Leasing and Availability Analysis, Map of Nonattainment and Class I areas (July 2019), *found at*: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd668400.pdf
[56] U.S. Dept. of Agriculture, U.S. Dept. of the Interior, and U.S. Environmental Protection Agency, Memorandum of Understanding among the Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions, *available at:* https://www.epa.gov/sites/production/files/2014-08/documents/air-quality-analyses-mou-2011.pdf.

emissions, in compliance with NEPA's requirement that the agency identify mitigation measures, 40 C.F.R. § 1508.25, and consider all reasonable alternatives. *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1217 (9th Cir. 2008) (citing 40 C.F.R. § 1502.14(a)).

1. *Types of Air Emissions*

The Forest Service must start its air quality analysis with an inventory of all potential hazardous and criteria pollutants that could be emitted in the fracking process.

Chemical additives used in the fracking process are sources of air pollution from fracking operations. These chemicals fall into a number of categories: *breakers* to lower fracking fluid viscosity before fracking fluid flows back, *proppants* to keep newly-formed fractures open, *gelling agents* to pry open fractures, *biocides* to prevent bacteria from degrading gelling agents, *carriers* for aiding in transport of other fluids, and *crosslinkers* to increase viscosity of fluids to increase fracking effectiveness.[57]

Many chemicals amongst these categories are designated as Hazardous Air Pollutants (HAPs), which can enter the air during the venting of gases during fracking or the evaporation of chemicals from fracking and produced fluids, leading to dangerous human exposures.[58] For instance, ethylbenzene, formaldehyde, and methylene chloride are all known or suspected carcinogens, while methanol is linked to reproductive harm, and hydrochloric acid and hydrofluoric acid can cause both eye irritation and respiratory harm.[59] Therefore, being in close proximity to fracking operations can lead to serious health effects. Some of the same chemicals are used in both fracking and conventional oil and gas operations, so some risks posed by fracking are also found with conventional methods.[60]

There are also emissions from other aspects of the oil and gas extraction process, including the emission of natural gas itself, in forms such as methane (predominantly) and ethane. For instance, hydrogen sulfide is contained in natural gas, with long-term exposure to hydrogen sulfide linked to respiratory infections, eye, nose, and throat irritation, breathlessness, nausea, dizziness, confusion, and headaches.[61] Also, the diesel equipment used to pump the

[57] Stringfellow, William et al., Identifying chemicals of concern in hydraulic fracturing fluids used for oil production, 220 Environmental Pollution 413 (2017), abstract available at https://www.sciencedirect.com/science/article/pii/S0269749116314920.

[58] Sierra Club et al., Comments on New Source Performance Standards: Oil and Natural Gas Sector; Review and Proposed Rule for Subpart OOOO (Nov. 30, 2011) ("Sierra Club Comments") at 13.

[59] Agency for Toxic Substances and Disease Registry (ATSDR), ATSDR A-Z Index, https://www.atsdr.cdc.gov/az/a.html (last visited on July 12, 2018) ("ASTDR A-Z Index"); Californians Against Fracking, Fracking and Dangerous Drilling in California, Briefing Book, Center for Biological Diversity (Accessed July 13, 2018), https://www.biologicaldiversity.org/campaigns/california_fracking/pdfs/fracking-and-drilling-in-california.pdf.

[60] Stringfellow, William et al., Comparison of chemical use between hydraulic fracturing, acidizing, and routine oil and gas development, 12 PLoS One 4 (2017), available at http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0175344&type=printable.

[61] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Report to Congress on Hydrogen Sulfide Air Emissions Associated with the Extraction of Oil and Natural Gas (EPA-453/R-93-045) at i (Oct. 1993) ("USEPA 1993").

fracking fluids into the well produces nitrogen oxide ("NOx") and particulate matter ("PM") emissions. Additionally, some volatile organic compounds ("VOCs"), such as the BTEX compounds (benzene, toluene, ethylbenzene, and xylene), when exposed to light can transform into particulate matter (PM). When gases are flared instead of vented, the combustion during flaring may cause emissions of PM and NOx.[62] NOx and PM are both criteria pollutants which must be regulated under the National Ambient Air Quality Standards (NAAQS) due to their potential to cause primary and secondary health effects. They both contribute to the formation of ozone, another criteria pollutant.[63]Concentrations of these criteria pollutants along with two others, carbon monoxide and sulfur dioxide, have been shown to increase in regions where unconventional oil and gas recovery techniques are permitted. Criteria pollutants are associated with an array of health impacts:[64]

> *Nitrogen oxides* (NOx) react with ammonia, moisture, and other compounds to form small particles. These small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory diseases, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death. NO_x and volatile organic compounds react in the presence of heat and sunlight to form ozone.
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> *Particulate matter* (PM) - especially fine particles - contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including: premature death in people with heart or lung disease, increased mortality, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.[65]
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> *Sulfur Dioxide* (SO_2) – has been shown to cause an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms.[66] Studies also show a connection between short-term exposure and increased visits to emergency departments

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[62] California Council on Science and Technology, Advanced Well Stimulation Technologies in California (2016) ("CCST 2016"), *available at:* http://ccst.us/publications/2014/160708-blm-report.pdf, at 248; McKenzie, Lisa M. et al., Human Health Risk Assessment of Air Emissions From Development of Unconventional Natural Gas Resources, 424 Science of the Total Environment 79 (2012) ("McKenzie 2012), abstract available at https://www.sciencedirect.com/science/article/pii/S0048969712001933; Shonkoff, Seth B.C. et al., Environmental Public Health Dimensions of Shale and Tight Gas Development, 122 Environmental Health Perspectives 787 (2014) ("Shonkoff 2014"), available at https://ehp.niehs.nih.gov/1307866/.

[63] U.S. Environmental Protection Agency, Criteria Air Pollutants, https://www.epa.gov/criteria-air-pollutants (last visited on July 10, 2018.).

[64] U.S. Environmental Protection Agency, Criteria Air Pollutants, https://www.epa.gov/criteria-air-pollutants (last visited on July 10, 2018.).

[65] U.S. Environmental Protection Agency, Particulate Matter, (PM) https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm (Accessed July 13, 2018); Ostro, Bart et al., Long-term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study, 118 Environmental Health Perspectives 3 (2010), available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2854764/.

[66] U.S. Environmental Protection Agency, Sulfur Dioxide, available at https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects (accessed July 13, 2018).

> and hospital admissions for respiratory illnesses, particularly in at-risk populations including children, the elderly, and asthmatics.[67]
>
> *Carbon Monoxide* (CO) can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death.[68] Exposure to CO can reduce the oxygen-carrying capacity of the blood. People with several types of heart disease already have a reduced capacity for pumping oxygenated blood to the heart, which can cause them to experience myocardial ischemia (reduced oxygen to the heart), often accompanied by chest pain (angina), when exercising or under increased stress.[69] For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands of exercise or exertion.[70]
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> *Ozone* (O_3) can trigger or worsen asthma and other respiratory ailments.[71] It has been linked to pneumonia, COPD, asthma, bronchitis, emphysema, and premature death. Ground level ozone can have harmful effects on sensitive vegetation and ecosystems. Ozone may also lead to loss of species diversity and changes to habitat quality, water cycles, and nutrient cycles, and may reduce visibility.

VOCs, NOx, methane, and ethane are potent ground-level (tropospheric) ozone precursors that are emitted by oil and gas drilling and fracking operations.[72] VOCs can form ground-level (tropospheric) ozone when combined with NO_X from compressor engines, turbines, other engines used in drilling, and flaring,[73] in the presence of sunlight. Many regions around the country with substantial oil and gas operations are now suffering from extreme ozone levels due to heavy emissions of these pollutants.[74] A recent study of ozone pollution in the Uintah Basin of northeastern Utah, a rural area that experiences hazardous tropospheric ozone concentrations,

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[67] *Id.*
[68] U.S. Environmental Protection Agency, Carbon Monoxide, *available at:* https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#Effects (accessed July 13, 2018).
[69] *Id.*
[70] *Id.*
[71] U.S. Environmental Protection Agency, Health Effects of Ozone Pollution, *available at:* https://www.epa.gov/ozone-pollution/health-effects-ozone-pollution (accessed July 10, 2018).
[72] U.S. Environmental Protection Agency, Integrated Science Assessment (ISA) for Ozone (O3) and Related Photochemical Oxidants (2013), available at http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=511347.
[73] *See, e.g.*, U.S. Environmental Protection Agency, Oil and Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution: Background Technical Support Document for Proposed Standards at 3-6 (July 2011); Armendariz, Al, Emissions for Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements (2009) ("Armendariz 2009") at 24, available at https://www.edf.org/sites/default/files/9235_Barnett_Shale_Report.pdf.
[74] Armendariz 2009 at 1, 3, 25-26; Koch, Wendy, Wyoming's Smog Exceeds Los Angeles' Due to Gas Drilling, USA Today, May 9, 2011, available at https://content.usatoday.com/communities/greenhouse/post/2011/03/wyomings-smog-exceeds-los-angeles-due-to-gas-drilling/1; Craft, Elena, Environmental Defense Fund, Do Shale Gas Activities Play a Role in Rising Ozone Levels (2012), available at http://blogs.edf.org/texascleanairmatters/2012/07/10/do-shale-gas-activities-play-a-role-in-rising-ozone-levels/.

found that oil and gas operations were responsible for 98 to 99 percent of VOCs and 57 to 61 percent of NO_X emitted from sources within the Basin considered in the study's inventory.[75]

Ethane is a greenhouse gas that breaks down and reacts with sunlight to create ozone or smog. Ethane emissions have risen steeply in recent years due to U.S. oil and gas production. A recent study documented that ethane emissions in the Northern Hemisphere increased by about 400,000 tons annually between 2009 and 2014, with the majority coming from North American oil and gas activity, reversing a decades-long decline in ethane emissions.[76] About 60 percent of the drop in ethane levels that occurred over the past 40 years has already been made up in the past five years. At this rate, U.S. ethane levels are expected to hit 1970s levels in about three years. About two percent of global ethane emissions originate from the Bakken Shale oil and gas field alone, which emits 250,000 tons of ethane per year.[77] Because global ethane levels were decreasing until 2009, the U.S. shale gas boom is thought to be responsible for the global increase in levels since 2010.

Fracking can pollute air hundreds of miles from the well pad. For example, ethane pollution in Baltimore, Maryland and Washington, D.C, has been attributed to the rapidly increasing natural gas production in the upwind, neighboring states of Pennsylvania and West Virginia.[78]

Likewise, the BTEX compounds, which contribute to the formation of criteria pollutants, pose great potential harms. Benzene, for instance, is a known human carcinogen that has been linked to blood disorders such as leukemia, immune system damage and chromosomal mutations. The other BTEX compounds (toluene, ethylbenzene, xylene) have varying effects, including damage to the brain and nervous system, kidneys, and liver, with symptoms of exposure including fatigue, drowsiness, headaches, dizziness, confusion, eye and respiratory tract irritation, and loss of muscle coordination.[79]

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[75] Lyman, Seth & Howard Shorthill, Final Report: 2012 Uintah Basin Winter Ozone & Air Quality Study, Utah Department of Environmental Quality (2013) ("Lyman 2013), available at https://binghamresearch.usu.edu/files/2013%20final%20report%20uimssd%20R.pdf.

[76] Helmig, Detlev et al., Reversal of Global Atmospheric Ethane and Propane Trends Largely Due to U.S. Oil and Natural Gas Production, 9 Nature Geoscience 490 (2016), abstract available at https://www.nature.com/articles/ngeo2721.

[77] Kort, Eric A. et al., Fugitive Emissions From the Bakken Shale Illustrate Role of Shale Production in Global Ethane Shift, 43 Geophysical Research Letters 4617 (2016), available at https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL068703.

[78] Vinciguerra, Timothy et al, Regional Air Quality Impacts of Hydraulic Fracturing and Shale Natural Gas Activities: Evidence From Ambient VOC Observations, 110 Atmospheric Environment 144 (2015), abstract available at https://www.sciencedirect.com/science/article/pii/S1352231015002800.

[79] Suh, H. H., et al., Criteria air pollutants and toxic air pollutants. *Environmental Health Perspectives*, *108* (2000) (Suppl 4), 625, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637676/pdf/envhper00313-0028.pdf; Agency for Toxic Substances and Disease Registry, *ATSDR A-Z Index, available at:* https://www.atsdr.cdc.gov/az/a.html; Jia, C., & Batterman, S., A critical review of naphthalene sources and exposures relevant to indoor and outdoor air, 7 International Journal of Environmental Research and Public Health 7 (2010) 2903-2939, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2922736/.

Due to such chemical prevalence, research continues to mount on the health risks of fracking, well stimulation, and other oil and gas activities.[80] Research has found that people living near drilling sites have a higher risk for developing cancer,[81] increased asthma attacks,[82] higher hospitalization rates, and more upper respiratory problems and rashes.[83] For pregnant women, living closer to drilling sites is associated with a higher risk of having babies with birth defects, high-risk pregnancies and premature births, and low-birthweight babies.[84]

2. Sources of Air Emissions

Harmful air pollutants are emitted during every stage of unconventional oil and gas development, including drilling, completion, well stimulation, production, and disposal, as well as from transportation of water, sand, and chemicals to and from the well pad.[85] The well stimulation stage can emit diesel exhaust, VOCs, particulate matter, ozone precursors, silica, and acid mists.[86]

Drilling and casing the wellbore require substantial power from large equipment. The engines used typically run on diesel fuel, which emit particularly harmful types of air pollutants when burned. Similarly, high-powered pump engines are used in the fracturing and completion phase. This too can amount in large volumes of air pollution. In total, VOCs emitted by car and truck engines, as well as the drilling and completion stages of oil and gas production, make up about 3.5 percent of the gases emitted by oil or gas operations.[87] Vehicles and equipment are also responsible for generating harmful particulate matter.[88]

Flaring and venting of gas are also potential sources of air emissions. Gas flaring and venting can occur in both oil and gas recovery processes when underground gas rises to the

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[80] PSE Healthy Energy, The Science on Shale Gas Development, *available at:* https://www.psehealthyenergy.org/our-work/publications/archive/the-science-on-shale-gas-development/ (last visited on July 10, 2018).

[81] McKenzie, L.M. et al., Childhood hematologic cancer and residential proximity to oil and gas development, 12 PLoS One 2 (2017), available at http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0170423.

[82] Rasmussen, Sara G. et al., Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations, 176 JAMA Internal Medicine 9 (2016), https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2534153.

[83] Rabinowitz, Peter M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania, 123 Environmental Health Perspectives 21 (2015), https://ehp.niehs.nih.gov/1307732/.

[84] Stacy, Shaina L. et al., Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania, 10 PLoS One 6 (2015), http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0126425.

[85] McCawley, Michael, Air Contaminants Associated with Potential Respiratory Effects from Unconventional Resource Development Activities, 36 Seminars in Respiratory and Critical Care Medicine 379 (2015), abstract available at https://www.ncbi.nlm.nih.gov/pubmed/26024346; Shonkoff 2014.

[86] *Id.*

[87] Brown, Heather, Memorandum to Bruce Moore, U.S.EPA/OAQPS/SPPD re Composition of Natural Gas for use in the Oil and Natural Gas Sector Rulemaking, July 28, 2011 ("Brown Memo") at 3, available at https://psbweb.co.kern.ca.us/UtilityPages/Planning/EIRS/mckittrick_landfill/Vol5/Brown%202011_Composition%20NatGas%20Use%20Oil%20Natural%20Gas%20Sector%20Rules.pdf.

[88] Earthworks, Sources of Oil and Gas Pollution (2011), available at https://earthworks.org/issues/sources_of_oil_and_gas_air_pollution/; Bay Area Air Quality Management District, Particulate Matter Overview, Particulate Matter and Human Health (2012).

surface and is not captured as part of production. Emissions from flaring typically include carbon monoxide, nitrogen oxides, benzene, formaldehyde and xylene, but levels of these smog-forming compounds are seldom measured directly.[89]

Fugitive emissions can occur at every stage of extraction and production, often leading to high volumes of gas being released into the air. Methane emissions from oil and gas production are as much as 270 percent greater than previously estimated by calculation.[90] Studies show that fugitive emissions from pneumatic valves (which control routine operations at the well pad by venting methane during normal operation) and equipment leaks are higher than EPA estimates.[91] This is of great concern because ground-level ozone can be formed by methane in substantial quantities as it interacts with nitrogen oxides and sunlight.[92] One paper modeled reductions in various anthropogenic ozone precursor emissions and found that "[r]educing anthropogenic CH_4 emissions by 50% nearly halves the incidence of U.S. high-O_3 events…."[93]

Evaporation from pits can also contribute to air pollution. Pits that store drilling waste, produced water, and other waste fluid may be exposed to the open air. Chemicals mixed with the wastewater—including the additives used to make fracking fluids, as well as volatile hydrocarbons, such as benzene and toluene, brought to the surface with the waste—can escape into the air through evaporation. Some pits are equipped with pumps that spray effluents into the air to hasten the evaporation process. For example, evaporation from fracking waste pits in western Colorado was found to have added tons of toxic chemicals to the air, increasing air pollution in Utah.[94] In Texas, toxic air emissions from fracking waste pits are unmonitored and unregulated.[95] In California, unlined disposal pits for drilling and fracking waste are documented

[89] Physicians for Social Responsibility and Concerned Health Professionals of NY, Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking, Fourth Edition, November 17, 2016 ("PSR 2016"), available at http://concernedhealthny.org/wp-content/uploads/2018/03/Fracking_Science_Compendium_5FINAL.pdf.

[90] Miller, Scot M. et al., Anthropogenic Emissions of Methane in the United States, 110 PNAS 20018 (2013), http://www.pnas.org/content/110/50/20018.

[91] Allen, David et al., Measurements of Methane Emissions at Natural Gas Production Sites in The United States, 110 PNAS 17768 (2013) ("Allen 2013"), available at http://www.pnas.org/content/110/44/17768; Harriss, Robert et al., Using Multi-Scale Measurements to Improve Methane Emission Estimates from Oil and Gas Operations in the Barnett Shale Region, Texas, 49 Environ. Sci. Technol. 7524 (2015), available at https://pubs.acs.org/doi/pdf/10.1021/acs.est.5b02305.

[92] Fiore, Arlene et al., Linking Ozone Pollution and Climate Change: The Case for Controlling Methane, 29 Geophys. Res Letters 19 (2002) ("Fiore 2002"), available at https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2002GL015601; U.S. Environmental Protection Agency, Oil and Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews Proposed Rule, 76 Fed. Reg. 52,738 (Aug 23, 2011).

[93] Fiore 2002; *see also* Martin, Randal et al., Final Report: Uinta Basin Winter Ozone and Air Quality Study Dec 2010 - March 2011 (2011) at 7, available at https://binghamresearch.usu.edu/files/edl_2010-11_report_ozone_final.pdf.

[94] Maffly, Brian, Utah grapples with toxic water from oil and gas industry, The Salt Lake Tribune, August 28, 2014, *available at:* http://archive.sltrib.com/story.php?ref=/sltrib/news/58298470-78/danish-flats-ponds-company.html.csp; The company responsible for the waste pits was found to have operated without a permit, underreported emissions and provided erroneous data to regulators.

[95] Center for Public Integrity, Open Pits Offer Cheap Disposal for Fracking Sludge But Health Worries Mount, October 2, 2014, available at https://www.publicintegrity.org/2014/10/02/15826/open-pits-offer-cheap-disposal-fracking-sludge-health-worries-mount.

sources of contamination.[96] Even where waste fluid is stored in so-called "closed loop" storage tanks, fugitive emissions can escape from tanks.

Truck traffic related to oil and gas extraction contributes to air emissions. Trucks capable of transporting large volumes of chemicals and waste fluid typically use large engines that run on diesel fuel, also increasing threats of NO_x and PM emissions.

3. Health Impacts of Increased Air Pollution

The potential harms resulting from increased exposure to the dangerous air pollutants from unconventional oil and gas development are serious and wide-ranging. A growing body of scientific research has documented adverse public health impacts from unconventional oil and gas development, including studies showing air pollutants at levels associated with reproductive and developmental harms and the increased risk of morbidity and mortality.[97] A comprehensive review of the risks and harms of fracking to public health came to several key findings related to air pollution: (1) "drilling and fracking emissions contribute to toxic air pollution and smog (ground-level ozone) at levels known to have health impacts," (2)"public health problems associated with drilling and fracking, including reproductive impacts and occupational health and safety problems, are increasingly well documented"; and (3)"fracking infrastructure poses serious potential exposure risks to those living near it."[98]

The range of illnesses that can result from the wide array of air pollutants from fracking were summarized in a study by Dr. Theo Colburn, which charts which chemicals have been shown to be linked to certain illnesses.[99] This study analyzed air samples taken during drilling operations near natural gas wells and residential areas in Garfield County, Colorado and detected

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[96] Stringfellow, William T. et al., Impacts of Well Stimulation on Water Resources, In California Council on Science and Technology, An Independent Assessment of Well Stimulation in California, Volume 2, Chapter 2 (2015) ("CCST 2015") at 110-113, available at https://ccst.us/publications/2015/160708-sb4-vol-II-2.pdf.

[97] Hays, Jake & Seth B.C. Shonkoff , Toward an Understanding of the Environmental and Public Health Impacts of Unconventional Natural Gas Development: A Categorical Assessment of the Peer-Reviewed Scientific Literature, 11 PLoS ONE e0154164 (2016), available at http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154164; Shonkoff 2014; Webb, Ellen et al., Developmental and reproductive effects of chemicals associated with unconventional oil and natural gas operations, 29 Rev Environ Health 307 (2014), available at https://pdfs.semanticscholar.org/ab6d/bfd71a203f3b864dfaa872b05174c06c8b51.pdf; McKenzie 2012; Clean Air Task Force, Fossil Fumes: A Public Health Analysis of Toxic Air Pollution From the Oil and Gas Industry, June 2016, *available at:* http://www.catf.us/resources/publications/files/FossilFumes.pdf.

[98] PSR 2016 at 17-22.

[99] Colborn, Theo, et al., Natural Gas Operations from a Public Health Perspective, 17 Human and Ecological Risk Assessment: An International Journal (2011), doi: 10.1080/10807039.2011.605662 ("Colborn 2011"), available at https://www.biologicaldiversity.org/campaigns/fracking/pdfs/Colborn_2011_Natural_Gas_from_a_public_health_perspective.pdf; Colborn, Theo, et al., An Exploratory Study of Air Quality near Natural Gas Operations, Human and Ecological Risk Assessment: An International Journal (2012), doi: 10.1080/10807039.2012.749447 ("Colborn 2012"), available at https://eplanning.blm.gov/epl-front-office/projects/nepa/68426/102904/125798/Colborn_2012__An_Exploratory_Study_of_Air_Quality_near_Natural_Gas_Operations.pdf.

57 chemicals between July 2010 and October 2011, including 44 with reported health effects.[100] For example:

> Thirty-five chemicals were found to affect the brain/nervous system, 33 the liver/metabolism, and 30 the endocrine system, which includes reproductive and developmental effects. The categories with the next highest numbers of effects were the immune system (28), cardiovascular/blood (27), and the sensory and respiratory systems (25 each). Eight chemicals had health effects in all 12 categories. There were also several chemicals for which no health effect data could be found.[101]

The study found extremely high levels of methylene chloride, which may be used as cleaning solvents to remove waxy paraffin that is commonly deposited by raw natural gas in the region. These deposits solidify at ambient temperatures and build up on equipment.[102] While none of the detected chemicals exceeded governmental safety thresholds of exposure, the study noted that such thresholds are typically based on "exposure of a grown man encountering relatively high concentrations of a chemical over a brief time period, for example, during occupational exposure."[103] Consequently, such thresholds may not apply to individuals experiencing "chronic, sporadic, low-level exposure," including sensitive populations such as children, the elderly, and pregnant women.[104] For example, the study detected polycyclic aromatic hydrocarbon (PAH) levels that could be of "clinical significance," as recent studies have linked low levels of exposure to lower mental development in children who were prenatally exposed.[105] In addition, government safety standards do not take into account "the kinds of effects found from low-level exposure to endocrine-disrupting chemicals…, which can be particularly harmful during prenatal development and childhood.[106]

Adverse health impacts documented among residents living near drilling and fracking operations include reproductive harms, increased asthma attacks, increased rates of hospitalization, ambulance runs, emergency room visits, self-reported respiratory problems and rashes, motor vehicle fatalities, trauma, and drug abuse. A 2016 review concluded:

> By several measures, evidence for fracking-related health problems is emerging across the United States. In Pennsylvania, as the number of gas wells increase in a community, so do rates of hospitalization. Drilling and fracking operations are correlated with elevated motor vehicle fatalities (Texas), asthma (Pennsylvania), self-reported skin and respiratory problems (southwestern Pennsylvania), ambulance runs and emergency room visits (North Dakota), infant deaths (Utah), birth defects (Colorado), high risk pregnancies (Pennsylvania), premature birth (Pennsylvania), and low birthweight (multiple states). Benzene levels in ambient air surrounding drilling and fracking operations are sufficient to elevate risks for

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[100] Colborn 2012 at pp. 21-22 (pages refer to page numbers in attached manuscript and not journal pages).
[101] Colborn 2012 at 11.
[102] *Id*. at 10.
[103] *Id*. at 11-12.
[104] *Id*. at. 12.
[105] *Id*. at 10-11.
[106] *Id*. at 12.

> future cancers in both workers and nearby residents, according to studies. Animal studies show that two dozen chemicals commonly used in fracking operations are endocrine disruptors that can variously disrupt organ systems, lower sperm counts, and cause reproductive harm at levels to which people can be realistically exposed.[107]

A rigorous study by Johns Hopkins University, which examined 35,000 medical records of people with asthma in Pennsylvania, found that people who live near a higher number of, or larger, active gas wells were 1.5 to 4 times more likely to suffer from asthma attacks than those living farther away, with the closest groups having the highest risk.[108] Relatedly, in a 2018 study of pediatric asthma-related hospitalizations, it was found that children and adolescents exposed to newly spudded unconventional natural gas development wells within their zip code had 1.25 times the odds of experiencing an asthma-related hospitalization compared to children who did not live in these communities. Furthermore, children and adolescents living in a zip code with any current or previous drilling activity had 1.19 times the odds of experiencing an asthma-related hospitalization compared to children who did not live in these communities. Amongst children and adolescents (ages 2-18), children between 2 and 6 years of age had the greatest odds of hospitalization in both scenarios.[109]

A recent Yale University study identified numerous fracking chemicals that are known, probable, or possible human carcinogens (20 air pollutants) and/or are linked to increased risk for leukemia and lymphoma (11 air pollutants), including benzene, 1,3-butadiene, cadmium, diesel exhaust, and polycyclic aromatic hydrocarbons.[110]

In a 2018 study by McKenzie et al. conducted in the Denver Julesberg Basin on the Colorado Northern Front Range (CNFR), it was found that the currently established setback distance of 152 m (500 ft) does little to protect people in that proximity. In analyses of nonmethane concentrations from 152 to >1600 m from oil and gas facilities, it was found that the EPA's minimum cumulative lifetime excess cancer risk benchmark of 1 in a million was exceeded. Cumulative lifetime excess cancer risk increased with decreasing distance from the nearest oil and gas facility. Residents living within 610 m of and oil and gas facility had an overall cancer risk in excess of the EPA's upper bound for remedial action of 1 in 10,000. Furthermore, residents within 152 m of an oil and gas facility had an overall excess cancer risk of 8.3 in 10,000, along with an increased likelihood of neurological, hematological, and

[107] PSR 2016 at 93.

[108] Rasmussen, Sara G. et al., Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations, 176 JAMA Internal Medicine 1334 (2016), available at https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2534153.

[109] Willis, Mary D. et al., Unconventional natural gas development and pediatric asthma hospitalizations in Pennsylvania, 166 Environmental Research 402 (2018), abstract available at https://www.ncbi.nlm.nih.gov/m/pubmed/29936288/.

[110] Elliot, Elise G. et al., A Systematic Evaluation of Chemicals in Hydraulic-Fracturing Fluids and Wastewater for Reproductive and Developmental Toxicity, 27 Journal of Exposure Science and Environmental Epidemiology 90 (2016), abstract available at https://www.nature.com/articles/jes201581.

developmental health effects. Over 95% of the total risk was due to benzene, with additional risk due to the presence of toluene, ethylbenzene, xylene, and alkanes.[111]

Numerous studies also suggest that higher maternal exposure to fracking and drilling can increase the incidence of high-risk pregnancies, premature births, low-birthweight babies, and birth defects. A study of more than 1.1 million births in Pennsylvania found evidence of a greater incidence of low-birth-weight babies and significant declines in average birth weight among pregnant women living within 3 km of fracking sites.[112] The study estimated that about 29,000 U.S. births each year occur within 1 km of an active fracking sties and "that these births therefore may be at higher risk of poor birth outcomes." A study of 9,384 pregnant women in Pennsylvania found that women who live near active drilling and fracking sites had a 40 percent increased risk for having premature birth and a 30 percent increased risk for having high-risk pregnancies.[113] Another Pennsylvania study found that pregnant women who had greater exposure to gas wells -- measured in terms of proximity and density of wells -- had a much higher risk of having low-birthweight babies; the researchers identified air pollution as the likely route of exposure.[114] In rural Colorado, mothers with greater exposure to natural gas wells were associated with a higher risk of having babies with congenital heart defects and possibly neural tube defects.[115]

Other studies have found that residents living closer to drilling and fracking operations had higher hospitalization rates[116] and reported more health symptoms including upper respiratory problems and rashes.[117]

Workers suffer high risks from toxic exposure and accidents.[118] One study of the occupational inhalation risks caused by emissions from chemical storage tanks associated with

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[111] McKenzie, Lisa et al., Ambient Non-methane Hydrocarbon Levels Along Colorado's Northern Front Range: Acute and Chronic Health Risks, 52 Environmental Science & Technology 4514 (2018), abstract available at https://pubs.acs.org/doi/ipdf/10.1021/acs.est.7b05983.

[112] Currie, Janet et al., Hydraulic fracturing and infant health: New evidence from Pennsylvania, 3 Science Advances e1603021 (2017), available at http://advances.sciencemag.org/content/3/12/e1603021.

[113] Casey, Joan A., Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA, 27 Epidemiology 163 (2016).

[114] Stacy, Shaina L. et al., Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania, 10 PLoS ONE e0126425 (2015).

[115] McKenzie, Lisa M., Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado, 122 Environmental Health Perspectives 412 (2014).

[116] Jemielita, Thomas et al., Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates, 10 PLoS ONE e0131093 (2015).

[117] Rabinowitz, Peter M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania, 123 Environmental Health Perspectives 21 (2015).

[118] Esswein, Eric J. et al., Occupational Exposures to Respirable Crystalline Silica During Hydraulic Fracturing, 10 Journal of Occupational and Environmental Hygiene 347 (2013); Esswein, Eric et al., Evaluation of Some Potential Chemical Exposure Risks during Flowback Operations in Unconventional Oil and Gas Extraction: Preliminary Results, 11 Journal of Occupational and Environmental Hygiene D174 (2013); Harrison, Robert J. et al., Sudden Deaths Among Oil and Gas Extraction Workers Resulting from Oxygen Deficiency and Inhalation of Hydrocarbon Gases and Vapors — United States, January 2010–March 2015, 65 MMWR Morb Mortal Wkly Rep 6 (2016); PSR 2016.

fracking wells found that chemicals used in 12.4 percent of wells posed acute non-cancer risks, chemicals used in 7.5 percent of wells posed acute cancer risks, and chemicals used in 5.8 percent of wells posed chronic cancer risks.[119] As summarized below:

> Drilling and fracking jobs are among the most dangerous jobs in the nation with a fatality rate that is five times the national average and shows no sign of abating. Occupational hazards include head injuries, traffic accidents, blunt trauma, burns, inhalation of hydrocarbon vapors, toxic chemical exposures, heat exhaustion, dehydration, and sleep deprivation. An investigation of occupational exposures found high levels of benzene in the urine of wellpad workers, especially those in close proximity to flowback fluid coming up from wells following fracturing activities. Exposure to silica dust, which is definitively linked to silicosis and lung cancer, was singled out by the National Institute for Occupational Safety and Health as a particular threat to workers in fracking operations where silica sand is used. At the same time, research shows that many gas field workers, despite these serious occupational hazards, are uninsured or underinsured and lack access to basic medical care.[120]

Methods of collecting and analyzing emissions data often underestimate health risks by failing to adequately measure the intensity, frequency, and duration of community exposure to toxic chemicals from fracking and drilling; failing to examine the effects of chemical mixtures; and failing to consider vulnerable populations.[121] Of high concern, numerous studies highlight that health assessments drilling and fracking emissions often fail to consider impact on vulnerable populations including environmental justice communities[122] and children.[123] For example, a recent analysis of oil and gas development in California found that 14 percent of the state's population totaling 5.4 million people live within a mile of at least one oil and gas well. More than a third of these residents, totaling 1.8 million people, also live in areas most burdened by environmental pollution.[124]

4. *The Forest Service Must Evaluate the Impact of Oil and Gas Pollution on Local and Regional Air Quality*

The Forest Service must use the foregoing information regarding the types, sources, and

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[119] Chen, Huan & Kimberly E. Carter, Modeling potential occupational inhalation exposures and associated risks of toxic organics from chemical storage tanks used in hydraulic fracturing using AERMOD, 224 Environmental Pollution 300 (2017), abstract available at https://www.ncbi.nlm.nih.gov/pubmed/28238366.
[120] PSR 2016 at 80.
[121] Brown, David et al., Understanding Exposure From Natural Gas Drilling Puts Current Air Standards to the Test, 29 Reviews on Environmental Health 277 (2014).
[122] Natural Resources Defense Council, Drilling in California: Who's At Risk?, October 2014 ("NRDC 2014"); Clough, Emily & Derek Bell, Just Fracking: A Distributive Environmental Justice Analysis of Unconventional Gas Development in Pennsylvania, USA, 11 Environmental Research Letters 025001 (2016); McKenzie, Lisa M. et al., Population Size, Growth, and Environmental Justice Near Oil and Gas Wells in Colorado, 50 Environmental Science & Technology 11471 (2016).
[123] Webb, Ellen et al., Potential Hazards of Air Pollutant Emissions From Unconventional Oil and Natural Gas Operations on The Respiratory Health of Children And Infants, 31 Reviews on Environmental Health 225 (2016).
[124] NRDC 2014.

health impacts of air pollution from fracking operations to inventory all potential emissions from fracking, and analyze the impact of increased air pollution on local communities.

In Texas, fracking is significantly impacting air quality. A modeling study of natural gas production in the Haynesville Shale in Northeast Texas and Northwest Louisiana projected that the shale gas operations would generate significant emissions of ozone precursors and increase 8-hour ozone values, with the potential to affect other regions due to ozone transport.[125]

Numerous studies in North Texas have linked induced oil and gas development to increased ozone formation in Texas non-attainment areas. A recent analysis by two professors from the University of North Texas – Mahdi Ahmadi and Kuruvilla John – suggest that there appears to be a growing influence of ozone formation from the areas in North Central Texas mostly associated with fracking. Thus, their preliminary analysis found that recent data show there was a greater reduction – about 4 percent—in the formation of ozone in the non-fracking region than in the area where fracking was occurring. The fracking appeared in particular to lead to higher ozone levels in the winter time.

After the year 2008, when as mentioned the number of high ozone days began to rise again, the two professors found that there was a 12% increase in the mean value of ozone in the fracking zone as compared to only a 4% increase in the non-fracking zone. During the winter time, the difference between the fracking region and non-fracking region was even more pronounced. [126]

A more recent study by the same authors pinpointed nitrogen oxide from compressor engines as being a major source of ozone formation in the Dallas-Fort Worth area.[127]

Both the Sierra Club and the group Downwinders at Risk submitted written testimony opposing TCEQ's proposed State Implementation Plan for ozone because among other issues it failed to take specific action to reduce emissions from compressor engines in the Dallas-Fort Worth area.[128] Specifically, those comments note:

> Recent NOx trends (Figure 5-10 in TCEQ's Proposal) indicate a fairly flat NOx trend for several NO monitors in the western area of the DFW area (Eagle Mtn. Lake, Denton, and Parker County monitors). These monitors are in areas more impacted by the growth in NOx sources for Oil and Gas Development that seem to be countering the normal reduction in NOx levels seen at other monitors due to fleet turnover reductions (on-road and Nonroad). These higher NOx levels in the modeling domain that seem to be fairly

[125] Kemball-Cook, Susan et al., Ozone Impacts of Natural Gas Development in the Haynesville Shale, 4 Environmental Science & Technology 9357 (2010).
[126] Ahmadi, M., et al., An Evaluation of the spatio-temporal characteristics of meteorologically-adjusted ozone trends in North Texas, Air Quality Technical Meeting, NCTCOG, Arlington, Texas (April 17, 2014).
[127] Ahmadi, M. and John, K., North Texas Ozone Attainment Initiative Project (Nov. 2015), *available at:* http://www.nctcog.org/trans/committees/aqtc/110615/Item_8.pdf.
[128] Sierra Club and Downwinders at Risk, Comments submitted on Docket No. 2015-1380-SIP, Commission Approval for Proposed Dallas-Fort Worth (DFW) 2008 Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2017 Attainment Year, SIP Project No. 2015-014-SIP-NR, January 29, 2016.

flat with no change since 2009 raise concern that the area is not seeing the NOx reductions needed to bring the ozone levels down at these monitors.[129]

In addition, the current understanding of the impacts of fracking on air quality is likely severely underestimated. Studies have consistently found that oil and gas operations in the Barnett Shale and Eagle Ford Shale are emitting significantly higher methane emissions than reported in national inventories, which is concerning due to methane's role as an ozone precursor and potent greenhouse gas.

Using remote sensing methods, one recent study found that methane emissions have grown significantly in Eagle Ford region and correspond to a leakage rate of 9.1 percent of regional natural gas production.[130] A study using airborne atmospheric measurements in spring and fall in the Barnett Shale region estimated that nearly 80 percent of the region's methane emissions come from gas and oil operations, including production, processing, and distribution in the urban areas of Dallas and Fort Worth. The study's estimate of methane emissions was higher than reported by industry to EPA's Greenhouse Gas Reporting Program and higher than the Emissions Database for Global Atmospheric Research inventory (EDGAR).[131] Another study that inventoried methane emissions in the 25-county Barnett Shale region using multiple data sources estimated that 64 percent of the region's methane emissions come from oil and gas operations. [132] The study's estimate of oil and gas emissions was higher than reported in EPA's Greenhouse Gas Inventory, EPA's Greenhouse Gas Reporting Program, and EDGAR by factors of 1.5, 2.7, and 4.3, respectively. Similarly, a coordinated top-down (atmospheric) and bottom-up (source-based) inventory of methane estimates in the Barnett Shale region found that oil and gas methane emissions are 90 percent larger than estimates from the EPA's Greenhouse Gas Inventory and correspond to 1.5 percent of natural gas production.[133] A larger scale study found that methane emissions from Texas, Oklahoma, and Kansas alone account for 24 percent of US methane emissions, and that drilling, processing, and refining activities over the south-central United States have emissions as much as 5 times larger than reported in EDGAR.[134]

In a presentation at a recent North Texas Council of Governments meeting, Dr. David Allen showed – based on preliminary data – that the emissions inventory for oil and gas operations was likely underreporting methane emissions because of the large leakage of methane emissions, particularly from pneumatic devices.[135] Overall, Allen reports that some 6000 tons of VOC emissions should likely be added to TCEQ's Barnett Shale Special Inventory. His report also showed consistently higher levels of hydrocarbons, particularly at Eagle Mountain Lake,

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[129] *Id*. at 5.

[130] Schneising, Oliver et al., Remote Sensing of Fugitive Methane Emissions From Oil and Gas Production in North American Tight Geologic Formations, 2 Earth's Future doi:10.1002/2014EF000265 (2014) ("Schneising 2014").

[131] Karion, Anna et al., Aircraft-based Estimate of Total Methane Emissions from the Barnett Shale Region, 49 Environmental Science & Technology 8124 (2015).

[132] Lyon, David R. et al., Constructing a Spatially Resolved Methane Emission Inventory for the Barnett Shale Region, 49 Environmental Science & Technology 8147 (2015).

[133] Zavala-Araiza, Daniel et al., Reconciling Divergent Estimates of Oil and Gas Methane Emissions, 112 PNAS 15597 (2015).

[134] Miller 2013.

[135] Allen, David, Air Quality Research Relevant to Shale Gas Production in the Dallas-Fort Worth Region, Air Quality Technical Meeting, NCTCOG, Arlington, Texas (April 17, 2014).

than was expected over a 20-month time period. However, understanding why this was occurring – and the impact of hydrocarbon development – was much more difficult to surmise. Still, the data suggest there are real ozone impacts of oil and gas development in the Dallas-Fort Worth region.

Further, increased ozone precursor emissions are expected in areas of the Eagle Ford shale. The Alamo Council of Governments (ACOG) through grants with the Texas Commission on Environmental Quality has produced a number of inventories and studies in recent years that are attempting to quantify the emissions and possible impacts on local and regional ozone formation. After an initial report found that moderate or increased development could raise ozone levels in the San Antonio area, ACOG was directed to conduct a more exhaustive emissions inventory and study. Currently, ACOG is conducting a 2015 emissions inventory, though a final report will not be developed until 2017.[136] The initial report finds that oil and gas activities in the Eagle Ford emitted an estimated 121 tons of NO_X and 223 tons of VOCs per ozone season day in 2012. However, NO_X emissions increase under the 2018 moderate growth scenario by 302 tons per day and under the high scenario by 423 tons per day. By 2018, VOC emissions are expected to increase significantly to 689 tons per ozone season day under the low development scenario and to 1,248 tons per ozone season day under the high development scenario.[137]

The Forest Service must consider the impact of the increased oil and gas development, triggered by additional leasing, on the formation of ozone in Texas. Several areas in Texas have ozone levels that exceed both the previous 2008 and the current 2015 health-based National Ambient Air Quality Standards (NAAQS) established by the United States Environmental Protection Agency under authority of the Clean Air Act (42 U.S.C. 7401 et seq.) that apply for outdoor air ozone throughout the country. These nonattainment statuses are further detailed in the next section.

The Forest Service must acknowledge the potential for new oil and gas activities in the planning area to contribute to or worsen non-attainment of the ozone standards. Any increase in these activities would undermine attainment of these standards and would therefore be significant.

5. *The Forest Service must conduct a full and thorough General Conformity Analysis as required by the Clean Air Act and also provide assurances of compliance with air quality standards, as required by the Federal Land Policy and Management Act*

Implementation of the Clean Air Act exemplifies cooperative governance between the states and the federal government. The Clean Air Act aims “to protect and enhance the quality of

[136] Alamo Area Council of Governments (AACOG), Oil and Gas Emission Inventory, Eagle Ford Shale, Quality, Assurance Procedure Plan (QAPP) (2015).
[137] Alamo Area Council of Governments, Oil and Gas Emissions Inventory Update, Eagle Ford Shale, Technical Report (2015).

the Nation's air resources . . . ."[138] The Clean Air Act states that, "No department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity" that does not conform to an approved state air quality implementation plan.[139] "The assurance of conformity . . . shall be an affirmative responsibility of the head of such . . . agency." To ensure conformity, agency actions must not "cause or contribute to any new violation of any [air quality] standard" or "increase the frequency or severity of any existing violation of any standard in any area."[140] This statute is very broadly applicable.

A SIP is a federally approved set of state regulations that are designed to prevent air quality deterioration and to restore clean air in areas that are out of attainment with federal standards. Conformity to a SIP as defined in the Clean Air Act,[141] means:

> (A) conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards; and
> (B) that such activities will not—
>> (i) cause or contribute to any new violation of any standard in any area;
>> (ii) increase the frequency or severity of any existing violation of any standard in any area; or
>> (iii) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

The "assurance of conformity" to a SIP "shall be an affirmative responsibility" of a federal agency.[142] For Federal actions not related to transportation plans, "a conformity determination is required for each criteria pollutant or precursor where the total of direct and indirect emissions of the criteria pollutant or precursor in a nonattainment or maintenance area caused by a Federal action would equal or exceed. . . 10/25/50/100 [tons/year.]".[143]

There are certain limited exceptions to general conformity requirements under the Clean Air Act, such as when emissions from federal actions are below de minimis thresholds. Portions of federal actions that require a permit under the Clean Air Act's new source review program, as set forth under 42 U.S.C. §§ 7410(a)(2)(c) and 7503, are also not subject to general conformity requirements.[144]

The purpose of general conformity is to "prevent the Federal Government from interfering with the States' abilities to comply with the CAA's requirements."[145] An action

[138] 42 U.S.C. § 7401(b)(1).
[139] 42 U.S.C. § 7506(c)(1).
[140] Id. § 7506(c)(1)(B).
[141] 42 U.S.C. § 7506(c)(1)(AB).
[142] 42 U.S.C. § 7506(c)(1).
[143] 40 C.F.R. § 95.153(b).
[144] *See* 40 C.F.R. § 93.150(d).
[145] *Dep't of Transp. v. Pub. Citizen*, 541 U.S. 752, 758 (2004).

“delays attainment only if its implementation *postpones* attainment beyond the date by which it would have been achieved without the project.”[146]

Before action is taken, a federal agency must make a determination that the federal action conforms to “certain threshold emission rates set forth in § 93.153(b).”[147] If the action’s direct and indirect emissions will exceed *de minimis* levels, then the agency must demonstrate conformity.[148] Because “[n]either the federal nor the state rule identify the form an agency must use when deciding whether a project necessitates a full-scale conformity determination,” courts have found it sufficient for an agency to explain their conformity decision in a NEPA document.[149] Thus, “[a]n agency need not prepare a stand-alone document explaining such a decision.”[150] Likewise, the Federal Land Policy and Management Act (FLPMA) requires the Secretary of the Interior, in developing and revising land use plans, to “provide for compliance with applicable pollution control laws, including State and Federal air, water, noise, or other pollution standards or implementation plans.”[151]

For purposes of conformity, direct emissions are those emissions that are “caused or initiated by the Federal action . . . occur at the same time and place as the action and are reasonably foreseeable.”[152] Indirect emissions are defined “as being (1) caused by federal action but occurring at a different time or place as the action, (2) reasonably foreseeable, (3) practically controlled by the agency, and (4) under the continuing program responsibility of the agency.”[153] “[T]he EPA has made clear that for purposes of evaluating causation in the conformity review process, some sort of ‘but for’ causation is sufficient.”[154] To demonstrate causation, projected emission concentrations with and without the project are compared.[155] If “the project’s emissions would result in either a new or aggravated violation relative to the initial emissions trajectory,” then the project does not conform.[156]

Ozone is a criteria pollutant under the federal Clean Air Act.[157] The Clean Air Act establishes a National Ambient Air Quality Standard (“NAAQS”) for each criteria pollutant that represents the maximum allowable concentration of each pollutant that can occur in the air and still protect public health.[158] In 2008, EPA published a final rule strengthening the ozone NAAQS by lowering the 8-hour standard to 0.075 ppm.[159] In response to evolving science and public health needs, in 2015 EPA again lowered the 2008 ozone NAAQS, setting a new, more

[146] *Nat. Res. Def. Council v. E.P.A.,* 661 F.3d 662, 665 (D.C. Cir. 2011).
[147] *Pub. Citizen*, 541 U.S. at 771.
[148] *Ctr. for Biological Diversity v. Bureau of Land Mgmt*., 833 F.3d 1136, 1148 (9th Cir. 2016); *see also* 40 C.F.R § 93.153(b)(1) (defines de minimis emission rates).
[149] *California ex rel. Imperial Cty. Air Pollution Control Dist. v. U.S. Dep't of the Interior*, 767 F.3d 781, 799 (9th Cir. 2014).
[150] *Id*.
[151] 43 U.S.C. § 1712(c)(8).
[152] 40 C.F.R. § 93.152.
[153] *California ex rel. Imperial Cty. Air Pollution Control Dist*., 767 F.3d at 799; *see also* § 93.152.
[154] *Pub. Citizen*, 541 U.S. at 772
[155] *Nat. Res. Def. Council*, 661 F.3d at 665.
[156] *Id*.
[157] 42 U.S.C. § 7408.
[158] *See* 42 U.S.C. § 7409.
[159] 73 Fed. Reg. 16,436 (Mar. 27, 2008).

stringent 8-hour limit of 0.070 ppm.[160] According to EPA, the new limit was necessary "to provide requisite protection of public health and welfare, particularly for at-risk groups including children, older adults, people of all ages with lung diseases such as asthma, and people who are active outdoors, both for recreational and work purposes. It will also improve the health of trees, plants, and ecosystems."[161]

EPA's decision to strengthen the ozone standard was based on numerous human health studies conducted over the past decade documenting the adverse effects of ozone on public health. Ozone concentrations are measured on an hourly basis.[162] An exceedance of the ozone standard occurs if the average of eight consecutive hourly readings exceeds 0.075 ppm, which is the 2008 NAAQS for ozone.[163] A violation of the standard occurs when the "3-year average of the annual fourth-highest 8-hour" ozone concentrations exceeds 0.075 ppm.[164]

When the 3-year average for ozone levels for any given region falls below 0.075ppm, the region is considered to be in attainment with the ozone NAAQS.[165] Conversely, when the 3-year ozone average is above 0.075 ppm, the region is considered a nonattainment area for ozone.[166]

A six-county Houston-Galveston-Brazoria (HGB) area including Brazoria, Chambers, Fort Bend, Galveston, Harris, and Montgomery Counties were designated nonattainment and classified marginal under the 2015 eight-hour ozone NAAQS, effective August 3, 2018. The HGB nonattainment area includes six of the eight counties that were designated nonattainment under the 2008 eight-hour ozone but does not include Liberty or Waller Counties, which were designated attainment/unclassified.[167] An eight-county HGB area including Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties was designated "nonattainment" and classified "marginal" under the 2008 eight-hour ozone NAAQS, effective July 20, 2012. The HGB area includes the same eight counties that were designated "nonattainment" under the 1997 eight-hour ozone standard.[168] On August 23, 2019, the EPA reclassified the eight-county HGB area from moderate to serious nonattainment. The attainment date for serious nonattainment areas is July 20, 2021 with a 2020 attainment year.[169]

A nine-county Dallas-Fort Worth (DFW) area including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise Counties was designated nonattainment and classified marginal under the 2015 eight-hour ozone NAAQS, effective August 3, 2018.[170] The

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[160] 80 Fed. Reg. 65,292 (Oct. 26, 2015).
[161] *Id*.
[162] 40 C.F.R. § 50.15.
[163] *Id*.
[164] *Id*.
[165] 42 U.S.C. § 7407(d)(1)(A)(ii).
[166] 42 U.S.C. § 7407(d)(1)(A)(i).
[167] Texas Commission on Environmental Quality, Houston-Galveston-Brazoria: *Current Attainment Status Compliance Report of HGB-area counties with the National Ambient Air Quality Standards (NAAQS)*, last modified October 18th, 2019, found at: https://www.tceq.texas.gov/airquality/sip/hgb/hgb-status.
[168] *Id*.
[169] *Id*.
[170] Texas Commission on Environmental Quality, Dallas-Fort Worth: *Current Attainment Status*

DFW nonattainment area includes nine of the ten counties that were designated nonattainment under the 2008 eight-hour ozone but does not include Rockwall County, which was designated attainment/unclassifiable. A 10-county DFW area including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties was designated nonattainment and classified moderate under the 2008 eight-hour ozone NAAQS, effective July 20, 2012.[171] On August 23, 2019, the EPA reclassified the 10-county DFW area from moderate to serious nonattainment. The attainment date for serious nonattainment areas is July 20, 2021 with a 2020 attainment year.[172]

The planning area for the Texas National Forests and Grasslands overlaps or is adjacent to both the DFW and HGB ozone non-attainment areas.[173] The need for the Forest Service and BLM to ensure conformity is underscored by the fact that Texas is failing to bring both the DFW and HGB ozone nonattainment areas into attainment with both the 2015 and 2008 ozone NAAQS. A conformity determination is especially necessary in this case. The Forest Service must comply with the CAA's General Conformity requirements in assessing whether the authorized leasing and subsequent development will cause or contribute to continued violations of the NAAQS.

A 2011 interagency guidance memorandum of understanding, signed by the Department of Interior, outlines a commitment by the agency to undergo detailed analyses of air quality compliance, with a particular focus on non-attainment areas. The MOU establishes "a clearly defined, efficient approach to compliance with [NEPA] regarding air quality . . . in connection with oil and gas development on Federal lands."[174] The MOU "provides for early interagency consultation throughout the NEPA process; common procedures for determining what type of air quality analyses are appropriate and when air modeling is necessary; specific provisions for analyzing and discussing impacts to air quality and for mitigating such impacts; and a dispute resolution process to facilitate timely resolution of differences among agencies."[175] The goal of this process is to ensure that "[F]ederal oil and gas decisions do not cause or contribute to exceedances of the National Ambient Air Quality Standards (NAAQS)."[176] The MOU outlines recommended technical, quantitative procedures to follow, which include identifying the reasonably foreseeable number of oil and gas wells and conducting an emissions inventory of criteria pollutants. Further air quality modeling is required if certain criteria are met, based on the level of emissions impact and the geographic location of the action.[177] The MOU indicates that

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Compliance Report of DFW-area counties with the National Ambient Air Quality Standards (NAAQS), last modified October 11th, 2019, found at: https://www.tceq.texas.gov/airquality/sip/dfw/dfw-status.

171 *Id*.

172 *Id*.

173 U.S. Dept. of Agriculture, U.S. Forest Service, Texas National Forests and Grasslands, Oil and Gas Leasing and Availability Analysis, Map of Nonattainment and Class I areas (July 2019), *found at*: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd668400.pdf .

174 Memorandum of Understanding Among the U.S. Department of Agriculture, U.S. Department of the Interior, and U.S. Environmental Protection Agency, regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions through the National Environmental Policy Act Process, Preamble (2011), available at https://www.epa.gov/sites/production/files/2014-08/documents/air-quality-analyses-mou-2011.pdf.

175 *Id*. at 4.

176 *Id*. at 1, 2.

177 *Id*. § V.E.1., pg. 9.

"[e]xisting reasonably foreseeable development scenarios can be used to identify the number of wells."[178]

In response to this interagency MOU, BLM implemented internal regulations in 2012 establishing a 10-step process for conducting a general conformity determination in compliance with the Clean Air Act section 176(c).[179] De minimis levels under EPA's General Conformity regulations are as follows (40 CFR 93.153(b)):

(1) For purposes of paragraph (b) of this section the following rates apply in nonattainment areas (NAA's):

	Tons/year
Ozone (VOC's or NOX):	
Serious NAA's	50
Severe NAA's	25
Extreme NAA's	10
Other ozone NAA's outside an ozone transport region	100
Other ozone NAA's inside an ozone transport region:	
VOC	50
NOX	100
Carbon Monoxide: All maintenance areas	100
SO2 or NO2: All NAA's	100
PM10:	
Moderate NAA's	100
Serious NAA's	70
PM2.5 (direct emissions, SO2, NOX, VOC, and Ammonia):	
Moderate NAA's	100
Serious NAA's	70
Pb: All NAA's	25

(2) For purposes of paragraph (b) of this section the following rates apply in maintenance areas:

	Tons/year
Ozone (NOX), SO2 or NO2:	
All maintenance areas	100
Ozone (VOC's)	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
Carbon monoxide: All maintenance areas	100
PM10: All maintenance areas	100
PM2.5 (direct emissions, SO2, NOX, VOC, and Ammonia)	100
All maintenance areas	100
Pb: All maintenance areas	25

[178] *Id.*
[179] U.S. Bureau of Land Management, Instruction Memorandum No. 2013-025, *Guidance for Conducting Air Quality General Conformity Determinations* (Dec. 4, 2012) https://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2013/IM_2013-025.html.

In addition to CAA General Conformity requirements, NEPA regulations repeatedly emphasize the need for effective and accurate public notice and involvement at each stage of the planning process. NEPA procedures must ensure "environmental information is available to public officials and citizens before decisions are made and before actions are taken."[180] NEPA regulations make it crystal clear that "[T]he information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA."[181] Accordingly, "agencies shall to the fullest extent possible…encourage and facilitate public involvement in decisions."[182]

NEPA's implementing regulations require that the agency "shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions," and shall ensure the scientific accuracy and integrity of environmental analysis.[183] The agency must disclose if information is incomplete or unavailable and explain "the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts."[184] The agency must also directly and explicitly respond to dissenting scientific opinion.[185]

Courts interpret these regulations as requiring a high level of accuracy in the information provided to the public, and the burden falls on the agency to meet this high standard. "[W]ith respect to public involvement, the way in which the information is provided is less important than that a sufficient amount of environmental information – *as much as practicable* – be provided so that a member of the public can weigh in on the significant decision that the agency will make in preparing the EIS.[186] It is the agency's duty to provide clear, consistent and accurate information so that the public is fully informed of the scope of the agency action.

In addition to NEPA information accuracy requirements, courts also interpret EPA CAA General Conformity regulations to include the latest, most accurate information. In *Border Power Plant Working Group v. DOE*, the Court clarified the legal standard for general conformity determinations, stating that a Federal action's conformity determination must rely "on the most recent estimates of emissions," (42 U.S.C. § 7506(c)(1)) and that the EPA requires "the latest and most accurate emission estimation techniques available . . . (2) such as actual stack test data from stationary sources which are part of the conformity analysis." 467 F. Supp. 2d 1040, 1054 (S.D. Cal. 2006) (quoting 40 C.F.R. § 51.859(b)(2)).

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[180] 40 C.F.R. § 1500.1(b).
[181] *Id*.
[182] *Id*. § 1500.2(d) (emphasis added).
[183] *Id*. § 1502.24.
[184] *Id*. § 1502.22(b)(1).
[185] *Id*. § 1502.9(b).
[186] *WildEarth Guardians v. Mont. Snowmobile Ass'n*, 790 F.3d 920, 926 (9th Cir. 2015) (quoting *Native Ecosystems Council v. U.S. Forest Serv*., 418 F.3d 953, 964 (9th Cir. 2005) (citing 40 C.F.R. § 1500.1(b)("To take the required 'hard look' at a proposed project's effects, an agency may not rely on incorrect assumptions or data in an EIS. It surely follows that the data the Forest Service provides to the public to substantiate its analysis and conclusions must also be accurate. If the wolverine habitat prediction map does not accurately depict the big game winter range, and the Forest Service ultimately worked from a different, accurate map, then it is the accurate map that must be disclosed to the public.")(internal quotations omitted).

Finally, the Federal Land Policy and Management Act (FLPMA), requires that in "development and revision of land use plans, the Secretary of the interior shall . . . *provide for compliance* with applicable pollution control laws, including State and Federal air, water, noise, or other pollution standards or implementation plans." 43 U.S.C. § 1712(c)(8) (emphasis added). This statutory language is expansive. To the extent BLM will authorize leasing in the planning area in reliance on the Forest Service's EIS and planning process, it must comply with these requirements.

In *Southern Utah Wilderness Alliance v. Burke*, 981 F. Supp. 2d 1099, 1111 (D. Utah 2013) (*SUWA*), the plaintiffs contended that a Utah Resource Management Plan (RMP) violated the "provide for compliance" provision of FLPMA for fine particulate matter and ozone. Specifically, the plaintiffs argued that BLM violated FLPMA's requirements by failing to demonstrate that off-road vehicle use authorized in the RMP would not result in NAAQS violations. BLM responded that its planning area did not contain any nonattainment areas for those pollutants. *Id.* The court agreed, finding that the "planning area is in an attainment zone," and accordingly the small increase in pollutants caused by the RMP would not cause concentrations to exceed the NAAQS." *Id.* In reaching its holding, the court presumed that emissions *do* result from an RMP, but it found that under the circumstances, the RMP was unlikely to cause an exceedance of a NAAQS. However, in the Texas NF and Grasslands planning area there is no question that the Forest Service and BLM are approving emission-generating activities within ozone nonattainment areas of DFW and HGB. Therefore the agencies must provide for compliance with the NAAQS as required by FLPMA.

D. The Forest Service Must Analyze the Impacts of Oil and Gas Leasing on Climate Change

The Forest Service must quantify greenhouse gas emissions that would result from oil and gas development, and analyze the severity of their effects and their significance. Oil and gas operations are a major cause of climate change; this is due to emissions from the operations themselves, and emissions from the combustion of the oil and gas produced. Under NEPA's requirement to analyze *indirect* as well as direct impacts, the Forest Service's environmental review must therefore include not only emissions from drilling operations, but the full "lifecycle" emissions from the combustion (and leakage) of the oil and gas produced.[187]

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[187] *See High Country Conservation Advocates v. United States Forest Serv*., 52 F. Supp. 3d 1174 (D. Colo. 2014); *Dine Citizens Against Ruining Our Env't v. United States Office of Surface Mining Reclamation & Enf't*, 82 F. Supp. 3d 1201 (D. Colo. 2015); *WildEarth Guardians v. United States Office of Surface Mining, Reclamation & Enf't*, 104 F. Supp. 3d 1208, 1230 (D. Colo. 2015); *Wildearth Guardians v. U.S. Office of Surface Mining, Reclamation & Enf't*, No. CV 14-103-BLG-SPW, 2015 WL 6442724 (D. Mont. Oct. 23, 2015) report and recommendation adopted in part, rejected in part sub nom. *Guardians v. U.S. Office of Surface Mining, Reclamation & Enf't*, No. CV 14-103-BLG-SPW, 2016 WL 259285 (D. Mont. Jan. 21, 2016); *see also* Council on Environmental Quality, Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts 11 (Dec. 18, 2014), *available at* https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance ("emissions from activities that have a reasonably close causal relationship to the Federal action, such as those that may occur as a predicate for the agency action (often referred to as upstream emissions) and as a consequence of the agency action (often referred to as downstream emissions) should be accounted for in the NEPA analysis."

1. *The EIS Must Accurately Quantify Potential Emissions Related to the Proposed Action*

The Forest Service must quantify greenhouse gas emissions that would result from new oil and gas development in the planning area. The Forest Plan EIS must take into account the full life-cycle emissions of oil and gas extracted within the planning area including, transportation emissions of extracted product to market or to refineries, refining and other processing, and combustion of the extracted end-use product. Failing to disclose the full scope of greenhouse gas emissions that could result from new leasing would be contrary to law.

Utilizing BLM's own potential volume data from the Forest Plan's Reasonably Foreseeable Development Scenario, the estimated oil volume of 21,769,000 bbl represents lifecycle greenhouse gas emissions of up to 7,619,150 metric tons of CO2e and the estimated gas volume of 1,341,944,000 Mcf represents enormous lifecycle greenhouse gas emissions of up to 101,555,230 metric tons of CO2e. See Table 1 for underlying data sets and calculations:

Year	Horizontal Wells	Vertical Wells	All wells	Water Use (bbl)	Water Production (bbl)	Oil Production (bbl)	Gas Production (Mcf)	Oil GHGs (tons CO2e)	Gas GHGs (tons CO2e)	Oil and Gas GHGs (tons CO2e)
2018	5	3	8	619,000	7,429 000	259,000	32,670,000	90,650	2,286,900	2,377,550
2019	8	4	12	984,000	7,560 000	387,000	36,398,000	135,450	2,547,860	2,683,310
2020	10	5	15	1,230,000	7,730 000	510,000	40,238,000	178,500	2,816,660	2,995,160
2021	13	6	19	1,595,000	8,087 000	651,000	44,745,000	227,850	3,132,150	3,360,000
2022	15	8	23	1,849,000	8,633 000	802,000	49,924,000	280,700	3,494,680	3,775,380
2023	17	8	25	2,087,000	9,328 000	932,000	54,842,000	326,200	3,838,940	4,165,140
2024	16	8	24	1,968,000	10,058,000	994,000	58,035,000	347,900	4,062,450	4,410,350
2025	16	8	24	1,968,000	10,686,000	1,014,000	60,035,000	354,900	4,202,450	4,557,350
2026	17	8	25	2,087,000	11,461,000	1,073,000	63,077,000	375,550	4,415,390	4,790,940
2027	17	8	25	2,087,000	12,352,000	1,133,000	66,362,000	396,550	4,645,340	5,041,890
2028	17	9	26	2,095,000	13,309,000	1,184,000	69,393,000	414,400	4,857,510	5,271,910
2029	18	9	27	2,214,000	13,999,000	1,242,000	72,511,000	434,700	5,075,770	5,510,470
2030	18	9	27	2,214,000	14,370,000	1,284,000	75,311,000	449,400	5,271,770	5,721,170
2031	19	9	28	2,333,000	14,732,000	1,337,000	78,502,000	467,950	5,495,140	5,963,090
2032	19	9	28	2,333,000	15,068,000	1,385,000	81,829,000	484,750	5,728,030	6,212,780
2033	19	10	29	2,341,000	15,361,000	1,432,000	85,263,000	501,200	5,968,410	6,469,610
2034	20	10	30	2,460,000	15,592,000	1,485,000	88,978,000	519,750	6,228,460	6,748,210
2035	20	10	30	2,460,000	15,826,000	1,524,000	92,222,000	533,400	6,455,540	6,988,940
2036	20	10	30	2,460,000	16,043,000	1,556,000	94,796,000	544,600	6,635,720	7,180,320
2037	20	10	30	2,460,000	16,233,000	1,585,000	96,813,000	554,750	6,776,910	7,331,660
Total	**324**	**161**	**485**	**39,844,000**	**243,857,000**	**21,769,000**	**1,341,944,000**	**7,619,150**	**93,936,080**	**101,555,230**

TABLE 1: Well numbers, water use, water production, and oil and gas production and potential greenhouse gas pollution by year for National Forests and Grasslands in Texas.

Well number and ol, gas, and water volume data are from Reasonable Foreseeable Development Scenario for Oil and Gas Activities. National Forests and Grasslands in Texas.

USFS (2019) Table 4, at 11.

GHG estimates derived from models in: Potential Greenhouse Gas Emissions from U.S. Fossil Fuels. EcoShift Consulting (Aug 2015).

Available at: http://www.ecoshiftconsulting.com/wp-content/uploads/Potential-Greenhouse-Gas-Emissions-U-S-Federal-Fossil-Fuels.pdf

EcoShift models are further available at this online calculator: https://www.biologicaldiversity.org/climatepollutioncalculator/

Potential lifecycle greenhouse gas emissions for resultant oil and gas volumes were generated using a peer-reviewed carbon calculator and lifecycle greenhouse gas emissions model developed by EcoShift consulting.[188] This model is not novel in its development or methodology. Numerous greenhouse gas calculation tools exist to develop lifecycle analyses, particularly for fossil fuel extraction, operations, transport and end-user emissions.[189] Indeed, the Department of

[188] *See* Ecoshift Consulting, The potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels, Center for Biological Diversity and Friends of the Earth (2015), http://www.ecoshiftconsulting.com/wp-content/uploads/Potential-Greenhouse-Gas-Emissions-U-S-Federal-Fossil-Fuels.pdf.

[189] *See* Council on Environmental Quality, Revised draft guidance for greenhouse gas emissions and climate change impacts (2014), https://ceq.doe.gov/current_developments/GHG-accounting-tools.html.

Energy has historically utilized these types of lifecycle emissions analyses in NEPA review of oil and gas infrastructure projects.[190] Other federal agencies have begun to employ upstream, downstream and lifecycle greenhouse gas emissions analyses for NEPA review of energy-related projects.[191] Courts have upheld the viability and usefulness of lifecycle analyses, and adoption of this trend is clearly reflected in the CEQ Guidance on Climate Change . 81 Fed. Reg. 51, 866 at 11 (Aug. 5, 2016) ("This guidance recommends that agencies quantify a proposed agency action's projected direct and indirect GHG emissions. Agencies should be guided by the principle that the extent of the analysis should be commensurate with the quantity of projected GHG emissions and take into account available data and GHG quantification tools that are suitable for and commensurate with the proposed agency action").[192]

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[190] U.S. Department of Energy National Energy Technology Laboratory, Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States, DOE/NETL-2014/1649 (May 29, 2014) *available at* http://energy.gov/sites/prod/files/2014/05/f16/Life%20Cycle%20GHG%20Perspective%20Report.pdf. *See also,* U.S. Department of Energy National Renewable Energy Laboratory, Life Cycle Greenhouse Gas Emissions from Electricity Generation Fact Sheet, Pub No. NREL/FS-6A20-57817 (2013) *available at* http://www.nrel.gov/docs/fy13osti/57187.pdf; U.S. Department of Energy National Energy Technology Laboratory Role of Alternative Energy Sources: Natural Gas Technology Assessment, Pub No. DOE/NETL- 2012/1539 (NETL, 2012) *available at* https://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Life%20Cycle%20Analysis/LCA-2012-1539.pdf; U.S. Department of Energy National Energy Technology Laboratory, Life Cycle Greenhouse Gas Inventory of Natural Gas Extraction, Delivery and Electricity Production, Pub No. DOE/NETL-2011/1522 (NETL, 2011) *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/2013_applications/sierra_club_13-69_venture/exhibits_44_45.pdf; U.S. Department of Energy National Energy Technology Laboratory, Life Cycle Analysis: Natural Gas Combined Cycle (NGCC) Power Plant, Pub No DOE/NETL-403-110509 (Sep 10, 2012) (NETL, 2010) *available at* https://www.netl.doe.gov/energy-analyses/temp/FY13_LifeCycleAnalysisNaturalGasCombinedCycle(NGCC)PowerPlantFinal_060113.pdf.

[191] U.S. Bureau of Land Management, Final Supplemental Environmental Impact Statement for the Leasing and Underground Mining of the Greens Hollow Federal Coal Leas Tract, UTU-84102, 287 (Feb 2015) (BLM expressly acknowledged that "the burning of the coal is an indirect impact that is a reasonable progression of the mining activity" and quantified emissions from combustion without any disclaimer about other sources of coal. *Id* at 286. In that same EIS, BLM also acknowledged that truck traffic to haul coal would be extended as a result of the proposed lease approval, and this would generate additional emissions.) *See also*, U.S. Forest Service, Record of Decision and Final Environmental Impact Statement, Oil and Gas Leasing Analysis, Fishlake National Forest, 169 (Aug 2013) (Table 3.12-7: shows GHG emissions from transportation, offsite refining and end use; and total direct and indirect emissions. *See also id*., Appendix E/SIR-2 (more detailed calculations of direct and indirect emissions.)) U.S. Army Corps of Engineers, Final Environmental Impact Statement: Alaska Stand Alone Gas Pipeline, Volume 2 Sec. 5.20-70–71 (Oct. 2012) The Corps, in a 2012 EIS for an intrastate natural gas pipeline in Alaska, estimated downstream emissions from combustion of the natural gas that would be transported, and also discussed the potential for natural gas to displace other, dirtier fuel sources such as coal and oil.) U.S. Department of State, Final Supplemental Environmental Impact Statement for the Keystone XL Project, § 4.14.3, Appendix U (Jan. 2014)(The Department of State, as lead agency on the Keystone XL Pipeline Review conducted a relatively comprehensive life-cycle greenhouse gas analysis for the proposed pipeline, alternatives, and baseline scenarios that could occur if the pipeline was not constructed.) U.S. Environmental Protection Agency Region X, Letter from Dennis McLerran, Regional Administrator, to Randel Perry, U.S. Army Corps of Engineers Seattle District, re Gateway Pacific Projects (Jan 22, 2013) *available* at http://www.eisgatewaypacificwa.gov/sites/default/files/content/files/EPA_Reg10_McLerran.pdf#overlay-context=resources/project-library. (EPA submitted comments on the scope of impacts that should be evaluated in the coal terminal EIS that the Corps is preparing, in which it urged the Corps to conduct a lifecycle emissions analysis of GHG emissions from the coal that would be transported via the terminal.)

[192] *High Country Conservation Advocates v. United States Forest Serv*., 52 F. Supp. 3d 1174 (D. Colo. 2014) (Court held that the agencies' failure to quantify the effect of greenhouse gas (GHG) emissions from the mining lease

Meaningful consideration of greenhouse gas emissions (GHGs) is clearly within the scope of required NEPA review. *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1217 (9th Cir. 2008). As the Ninth Circuit has held, in the context of fuel economy standard rules:

> The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct. Any given rule setting a CAFE standard might have an "individually minor" effect on the environment, but these rules are "collectively significant actions taking place over a period of time" *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1216 (9th Cir. 2008)(quoting 40 C.F.R. § 1508.7).

The courts have ruled that federal agencies consider indirect GHG emissions resulting from agency policy, regulatory, and leasing decisions. For example, agencies cannot ignore the indirect air quality and climate change impact of decisions that would open up access to coal reserves. *See Mid States Coal. For Progress v. Surface Transp. Bd.*, 345 F.3d 520, 532, 550 (8th Cir. 2003); *High Country Conservation Advocates v. U.S. Forest Serv.*, 52 F.Supp. 3d 1174, 1197-98 (D.Colo. 2014). Nor can they ignore the climate change impacts of their decisions to authorize oil and gas leasing. *See, e.g, W. Org. of Res. Councils v. U.S. BLM,* 2018 U.S. Dist. LEXIS 49635 (D. Mont. 2018) (quantification of GHG emissions required for resource management plan); *Wilderness Workshop v. BLM*, 342 F.3d 1145, 1156 (Colo. Dist. 2018) (same); *San Juan Citizens All. v. U.S. Bureau of Land Mgmt.*, 326 F. Supp. 3d 1227, 1242-43 (D.N.M. 2018) (same for leasing decision); *Citizens for a Healthy Cmty. v. United States BLM*, 377 F. Supp. 3d 1223, 1237 (D. Colo. 2019) (same for drilling project decision); *see also WildEarth Guardians v. Zinke*, 368 F. Supp. 3d 41, 75 (D.D.C. 2019) (requiring agency to consider whether it was "reasonably possible" for it to quantify downstream GHG emissions).

NEPA requires "reasonable forecasting," which includes the consideration of "reasonably foreseeable future actions…even if they are not specific proposals" *N. Plains Res. Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067, 1079 (9th Cir. 2011) (citation omitted). That the agency cannot "accurately" calculate the total emissions expected from full development is not a rational basis for cutting off its analysis. "Because speculation is . . . implicit in NEPA," agencies may not "shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as crystal ball inquiry." *Id.* Indeed, the EA for a recent lease sale in Utah undercuts BLM's assertion here that GHGs cannot be quantified at the leasing stage[193]. *See High*

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modifications was arbitrary in violation of NEPA because the social cost of carbon protocol tool existed for such analysis under 40 C.F.R. § 1502.23 but the agencies did not provide reasons in the final EIS for not using the tool; and that the agencies' decision to forgo calculating the foreseeable GHG emissions was arbitrary in light of their ability to perform such calculations and their decision to include a detailed economic analysis of the benefits.) See also, *Dine Citizens Against Ruining Our Env't v. United States Office of Surface Mining Reclamation & Enf't*, 82 F. Supp. 3d 1201, 1213-1218 (D. Colo. 2015) (Court held that the agency failed to adequately consider the reasonably foreseeable combustion-related downstream effects of the proposed action. Also held that that combustion emissions associated with a mine that fed a single power plant were reasonably foreseeable because the agency knew where the coal would be consumed).

[193] U.S. Bureau of Land Management, Environmental Assessment for West Desert District, Fillmore Field Office, August 2015 Oil and Gas Lease Sale, pp. 57-58 (Dec. 2015); U.S. Bureau of Land Management, Greenhouse Gases

Country Conservation Advocates v. United States Forest Serv., 52 F. Supp. 3d 1174, 1196 (D. Colo. 2014) (decision to forgo calculating mine's reasonably foreseeable GHG emissions was arbitrary "in light of the agencies' apparent ability to perform such calculations").

The final CEQ *Guidance on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA review* is persuasive on the issue of federal agency review of greenhouse gas emissions as foreseeable direct and indirect effects of the proposed action. 81 Fed. Reg. 51,866 (Aug. 5, 2016). The CEQ guidance provides clear direction for the Forest Service to conduct a lifecycle greenhouse gas analysis because the modeling and tools to conduct this type of analysis are readily available to the agency:

> If the direct and indirect GHG emissions can be quantified based on available information, including reasonable projections and assumptions, agencies should consider and disclose the reasonably foreseeable direct and indirect emissions when analyzing the direct and indirect effects of the proposed action. Agencies should disclose the information and any assumptions used in the analysis and explain any uncertainties. To compare a project's estimated direct and indirect emissions with GHG emissions from the no-action alternative, agencies should draw on existing, timely, objective, and authoritative analyses, such as those by the Energy Information Administration, the Federal Energy Management Program, or Office of Fossil Energy of the Department of Energy. In the absence of such analyses, agencies should use other available information. 81 Fed. Reg. 51,866 at 16 (Aug. 5, 2016)(citations omitted).

CEQ's guidance even provides an example of where a lifecycle analysis is appropriate in a leasing context at footnote 42:

> The indirect effects of such an action that are reasonably foreseeable at the time would vary with the circumstances of the proposed action. For actions such as a Federal lease sale of coal for energy production, the impacts associated with the end-use of the fossil fuel being extracted would be the reasonably foreseeable combustion of that coal. *Id.*

Although the 2016 CEQ guidance has been "withdrawn for further consideration," 82 Fed. Reg. 16,576 (April 5, 2017), the underlying requirement to consider climate change impacts under NEPA, including indirect and cumulative combustion impacts foreseeably resulting from fossil fuels leasing decisions, has not changed. *See S. Fork Band*, 588 F.3d at 725; *Ctr. for Biological Diversity*, 538 F.3d at 1214-15; *Mid States Coalition for Progress*, 345 F.3d at 550; *WildEarth Guardians*, 104 F. Supp. 3d at 1230; *Dine Citizens Against Ruining Our Env't*, 82 F. Supp. 3d at 1201; *High Country Conservation Advocates*, 52 F. Supp. 3d at 1174.

It is reasonably foreseeable, as opposed to speculative, that the Forest Plan's authorization of leasing will induce oil and natural gas production, transmission and ultimate end-user climate change impacts. The effects of this induced production must be considered in the EIS. *See*, *e.g.*, *N. Plains Res. Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067, 1081-82

Estimate (West Desert District Nov 2015 Lease Sale), http://www.blm.gov/style/medialib/blm/ut/natural_resources/airQuality.Par.38

(9th Cir. 2011) (finding that NEPA review must consider induced coal production at mines, which was a reasonably foreseeable effect of a project to expand a railway line that would carry coal, especially where company proposing the railway line anticipated induced coal production in justifying its proposal); *Mid States Coal. for Progress v. Surface Transp. Bd.*, 345 F.3d 520, 549-50 (8th Cir. 2003) (environmental effects of increased coal consumption due to construction of a new rail line to reach coal mines was reasonably foreseeable and required evaluation under NEPA). The development of an area for lease and subsequent oil and gas production would certainly result in combustion of the extracted product. As courts have held in similar contexts, combustion emissions resulting from opening up a new area to development are "reasonably foreseeable," and therefore a "proximate cause" of the leasing. See *Mid States Coal. for Progress v. Surface Transp. Bd*., 345 F.3d 520, 549 (8th Cir. 2003) (holding that agency violated NEPA when it failed to disclose and analyze the future coal combustion impacts associated with the agency's approval of a railroad line that allowed access to coal deposits); *High Country Conserv'n Advocates v. United States Forest Serv.*, 52 F. Supp. 3d 1174, 1197 (D. Colo. 2014) (same with respect to GHG emissions resulting from approval of coal mining exploration project).

In both *Mid States Coalition* and *High Country*, the courts rejected the government's rationale that increased emissions from combustion of coal was not reasonably foreseeable because the same amount of coal would be burned without opening up the areas at issue to new coal mining. Both courts found this argument "illogical at best" and noted that "increased availability of inexpensive coal will at the very least make coal a more attractive option to future entrants into the utilities market when compared with other potential fuel sources, such as nuclear power, solar power, or natural gas." See *High Country*, 52 F. Supp. 3d at 1197 (quoting *Mid States Coalition*, 345 F.3d at 549). "On similar grounds, the development of new wells over the proposed areas for lease will increase the supply of [oil and natural gas]. At some point this additional supply will impact the demand for [oil and gas] relative to other fuel sources, and [these minerals] that otherwise would have been left in the ground will be burned. This reasonably foreseeable effect must be analyzed, even if the precise extent of the effect is less certain." *Id. See also WildEarth Guardians v. United States Office of Surface Mining, Reclamation & Enf't*, 104 F. Supp. 3d 1208, 1229-30 (D. Colo. 2015) (coal combustion was indirect effect of agency's approval of mining plan modifications that "increased the area of federal land on which mining has occurred" and "led to an increase in the amount of federal coal available for combustion.")[194]

Even if it were true that potential emissions cannot reasonably be estimated, or estimated with a high degree of accuracy, it is possible for the Forest Service to identify significant sources of greenhouse gas emissions, which would enable the identification of specific measures to

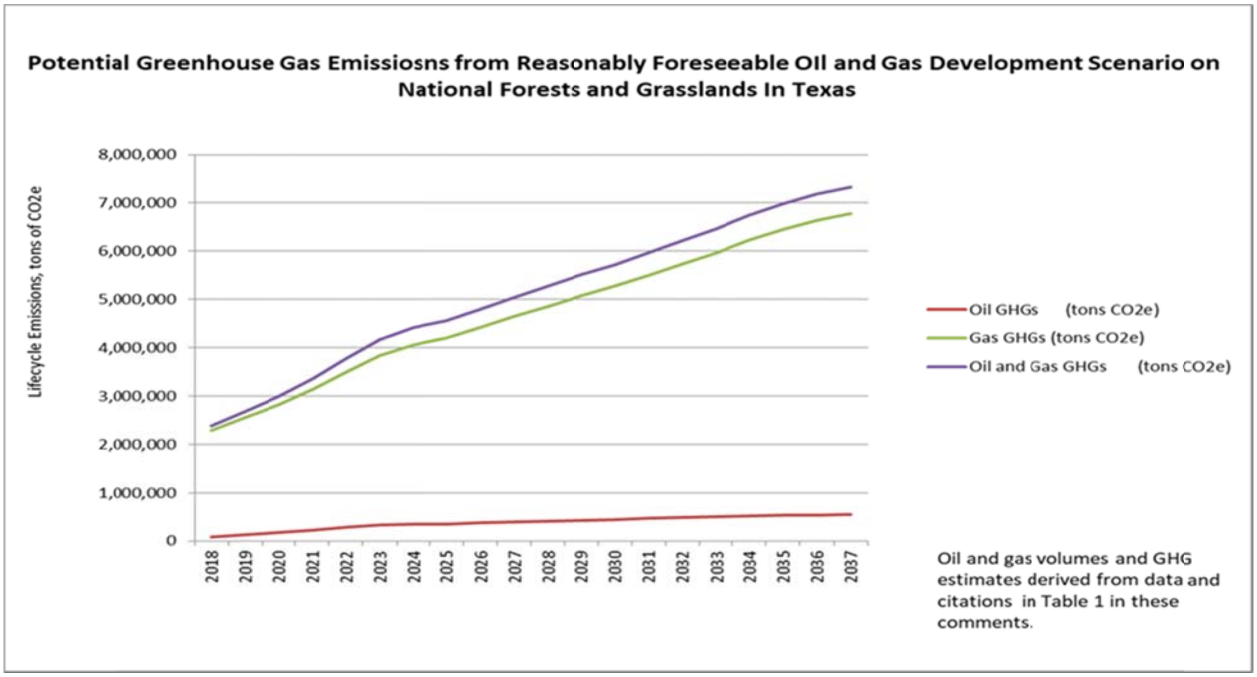
[194] *See also*, Council on Environmental Quality's Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews, 81 Fed. Reg. 51,866 at 14 (Aug. 5, 2016)(For example, NEPA reviews for proposed resource extraction and development projects typically include the reasonably foreseeable effects of various phases in the process, such as clearing land for the project, building access roads, extraction, transport, refining, processing, using the resource, disassembly, disposal, and reclamation. Depending on the relationship between any of the phases, as well as the authority under which they may be carried out, agencies should use the analytical scope that best informs their decision making.)

reduce emissions and an understanding of the extent to which certain emissions are avoidable. The extreme urgency of the climate crisis requires the Forest Service and BLM to pursue all means available to limit the climate change effects of its actions. Any emissions source, no matter how small, is potentially significant, such that the Forest Service should fully explore mitigation and avoidance options for all sources.

By delaying quantification until after a lease is issued, the Forest Service may prejudice the consideration of alternatives or leasing stipulations that would avoid or reduce greenhouse gas emissions to an extent not otherwise available after leasing. BLM has long (but incorrectly) maintained that leasing stipulations can only be imposed with the issuance of the lease. Thereafter, purportedly, its authority to condition drilling is limited to "reasonable measures" or "conditions of approval" that may not be "[in]consistent with lease rights granted." 43 C.F.R. § 3101.1-2. Cost-prohibitive measures could therefore potentially be barred. Further, measures to "minimize" impacts may be imposed, but those may not necessarily avoid impacts altogether. *Id*. Waiting until the drilling stage could also be too little too late, as various other actions may occur between leasing and drilling, such as the execution of unit agreements, or construction of roads or pipelines, all of which may narrow mitigation options available at the drilling stage. *See William P. Maycock et al.*, 177 I.B.L.A. 1, 20-21 (Dec. Int. 2008) (holding that unit agreements limit drilling-stage alternatives).

The calculations of potential lifecycle greenhouse gas emissions detailed above for this Forest Plan yield an enormous and significant number totaling over 101 million $MTCO_2E$. This is equivalent to the emissions of 26 coal-fired power plants operating for one year.[195] These emissions are clearly significant, as detailed below. The EIS must provide an analysis of the severity or significance of the reported greenhouse gas emissions. See Table 2 for the increase of GHG emissions projected in the Forest Plan's Reasonably Foreseeable Development Scenario:

[195] U.S. Environmental Protection Agency, Greenhouse Gas Equivalencies Calculator (2017) *available at*, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.



One widely used approach to evaluating the impact of GHG emissions is to estimate the costs of those emissions to society. The federal Interagency Working Group on the Social Cost of Carbon has developed estimates of the present value of the future costs of carbon dioxide, methane, and nitrous oxide emissions as a proxy for the magnitude and severity of those impacts.[196] These tools are easy to use by agencies, easy to understand by the public, and supported by years of peer-reviewed scientific and economic research. The EPA and other federal agencies have used these social cost protocols to estimate the effects of rulemakings on climate, and certain BLM field offices have used these tools in project level NEPA analysis. These protocols estimate the global financial cost of each additional ton of GHG pollution emitted to the atmosphere, taking into account factors such as diminished agricultural productivity, droughts, wildfires, increased intensity and duration of storms, ocean acidification, and sea-level rise.[197]

An agency must "consider every significant aspect of the environmental impact of a proposed action." *Baltimore Gas & Elec. Co. v. Natural Resources Defense Council*, 462 U.S. 87, 107 (1983) (quotations and citation omitted). This includes the disclosure of direct, indirect, and cumulative impacts of its actions, including climate change impacts and emissions. 40 C.F.R. § 1508.25(c). The need to evaluate such impacts is bolstered by the fact that "[t]he harms associated with climate change are serious and well recognized," and environmental changes caused by climate change "have already inflicted significant harms" to many resources around the globe. *Massachusetts v. EPA*, 549 U.S. 497, 521 (2007); *see also id*. at 525 (recognizing "the

[196] *See* Interagency Working Group on the Social Cost of Carbon, United States Government, Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866 (May 2013) at 2 (hereinafter 2013 TSD); Interagency Working Group on Social Cost of Greenhouse Gas, United States Government, Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide (August 2016) (last visited October 30, 2016).
[197] U.S. Environmental Protection Agency, The Social Cost of Carbon (accessed May 18, 2016).

enormity of the potential consequences associated with manmade climate change."). Failing to perform such analysis undermines the agency's decision-making process and the assumptions made. Additionally, the agency has a duty to fully analyze and assign significance to the negative consequences of leasing and fossil fuel development to the climate.

A comprehensive analysis of the GHG consequences of ending new oil leasing on U.S. federal lands and waters, and avoiding renewal of existing leases for resources that are not yet producing, found that ceasing new leasing would result in large GHG and climate benefits.[198] This study accounted for the effects of substitution by other fuels for the oil that would be foregone by ending new leasing. The study estimated that for each unit (QBtu) of federal oil production cut, other oil supplies would substitute for about half a unit (0.56 QBtu) and net oil consumption would drop by nearly half a unit (0.44 QBtu). In short, every barrel of federal oil left undeveloped would result in nearly half a barrel reduction in net oil consumption, with associated reductions in GHG emissions. The analysis estimated that ending new federal oil leasing would reduce 2030 global CO_2 emissions from oil consumption by 54 Mt CO_2, with an increase in CO_2 emissions from other fuels of 23 Mt CO_2, for a net emissions benefit of 31 Mt CO_2. The analysis recommended that "policy-makers should give greater attention to measures that slow the expansion of fossil fuel supplies."

As summarized by the study authors, oil and gas production operates in a global market, where increases or decreases in U.S. production translate into changes in prices and consumption:

> [T]he oil market is also highly global, with oil readily traded among countries, and substantial infrastructure in place to do so. The US both imports and exports oil, and world and domestic oil prices very closely track each other (US EIA 2016).
>
> For this reason, we expect that changes in US oil production would affect an integrated global oil market, an assumption also made by many other analysts that have looked at changes in US oil supply (Bordoff and Houser 2015; Rajagopal and Plevin 2013; Allaire and Brown 2012; Metcalf 2007; IEC 2012). Though in the past the oil market could be strongly influenced by cartel behavior among a small number of producers, many analysts now see the market as more likely to behave competitively (The Economist 2016; US EIA 2016), meaning that increases or decreases in supply do translate into shifts in prices and, in turn, consumption.[199]

Similarly, an analysis published in the prominent journal *Nature Climate Change* concluded that increased oil production would significantly increase global oil consumption as the result of greater supplies and lower global oil prices.[200] Using publicly available global oil

[198] Erickson, P. and M. Lazarus, How would phasing out US federal leases for fossil fuel extraction affect CO_2 emissions and 2°C goals?, Stockholm Environment Institute, Working Paper No. 2016-2 (2016).
[199] *Id.* at 23.
[200] Erickson, P. and M. Lazarus, Impact of the Keystone XL Pipeline on Global Oil Markets and Greenhouse Gas Emissions, 4 Nature Climate Change 778 (2016).

supply curves from the International Energy Agency and peer-reviewed elasticities, the analysis estimated that each barrel of increased oil production would result in an increase of 0.59 barrels of global oil consumption. Although this study focused on the effects of increases in Canadian tar sands production, the lead author stated the results are applicable to U.S. oil production and that each barrel of oil not produced in the U.S. leads to substantially reduced oil consumption.[201]

An analysis of the effects of removing subsidies for U.S. oil and gas production found that decreases in the U.S. oil and gas supply would result in substantial decreases in global oil and gas consumption.[202] In the case of oil, the model estimated that a decrease of 600,000 barrels per day in U.S. oil supply, resulting from a drop in U.S. oil production due to subsidy removal, would lead to a decrease in global oil consumption of 300,000 to 500,000 barrels per day.[203] In the model, the decreased U.S. oil supply is only partially replaced by other sources of U.S., OPEC, and other rest-of-world supply. In short, each U.S. barrel not developed would result in a net reduction in global oil consumption of 0.5 barrels to 0.8 barrels. Similarly, for natural gas, a 1.06 to 1.32 Tcf per year decrease in U.S. natural gas supply would lead to a net reduction in global gas consumption of 0.94 to 1.06 Tcf per year,[204] which translates into a net reduction in global gas consumption of 0.7 to 1 unit for each unit of U.S. natural gas left undeveloped.

An analysis by experts at Columbia University and the Rhodium Group on the effects of lifting U.S. crude oil export restrictions shows that U.S. oil production affects global crude oil prices,[205] which is only possible without perfect substitution. As illustrated in Figure 23 of the study, when U.S. crude oil exports are permitted, as they were by the lifting of the crude oil export ban in December 2015, all modeling groups agreed that the international oil market will respond to changes in U.S. production. Specifically, all modeling groups projected that global crude prices will decrease as U.S. production increases, resulting in an increase in global crude oil demand: "a 1.2 million b/d increase in U.S. production due to removing current export restrictions could result in anywhere between a 0 and 1 million b/d increase in global crude demand."[206] In short, this study demonstrates that crude oil operates in a global market, where increasing U.S. supply increases global consumption and resulting greenhouse gas pollution.

Finally, the modeling results from a Bureau of Ocean Energy Management (BOEM) analysis of lifecycle GHG emissions that would result from the 2017–2022 OCS Oil and Gas Leasing Final Proposed Program[207] estimated that leaving U.S. oil and gas undeveloped under the no-leasing alternative would result in a significant decrease in global oil consumption with

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[201] Erickson, Peter, Stockholm Environment Institute, personal communication, November 1, 2017.
[202] Metcalf, G, The Impact of Removing Tax Preferences for U.S. Oil and Gas Production, Council on Foreign Relations, August 2016; Erickson, P., Rebuttal: Oil Subsidies—More Material for Climate Change Than You Might Think, November 2, 2017, https://www.cfr.org/blog/rebuttal-oil-subsidies-more-material-climate-change-you-might-think
[203] *Id.* at Table 2.
[204] *Id.* at Table 3.
[205] Bordoff, J. and T. Houser, Navigating the U.S. Oil Export Debate, Columbia University Center on Global Energy Policy and the Rhodium Group (2015).
[206] *Id.* at 57.
[207] Wolvovsky, E. and Anderson, W., OCS Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon. BOEM OCS Report 2016-065. 44 pp (2016).

associated reductions in GHG pollution.[208] Importantly, BOEM's global market model, MarketSim, estimated that foreign oil consumption would be reduced under the No Action Alternative by "approximately 1, 4, and 6 billion barrels of oil for the low-, mid-, and high-price scenarios, respectively, over the duration of the 2017–2022 Program."[209] Under the mid-price scenario, the model projected that each barrel of oil left undeveloped under the No Action Alternative would result in approximately a half-barrel decrease in global oil consumption. Specifically, the choice to leave ~8 billion barrels of oil undeveloped under the No Action Alternative in the mid-price scenario[210] would result in a reduction in global oil consumption of 4 billion barrels of oil.[211]

Although BOEM did not calculate the GHG emissions reductions from the decrease in global oil consumption, energy experts at the Stockholm Environment Institute (SEI) calculated the GHG benefits. Using standard energy contents (from the US Department of Energy) and carbon contents (from the US Environmental Protection Agency), and discounting the oil used in products and not combusted (International Energy Agency), SEI estimated that the reduction in global oil consumption would result in a savings of 2.3 billion tonnes CO_2 in high-price scenarios for oil, 1.6 billion in mid-price scenarios, and 0.4 billion in the low-price scenarios.[212] As the SEI analysis points out, the decreases in global GHG emissions under the No Action Alternative are enormous:

> These *decreases* in rest-of-world emissions dwarf the official estimated *increases* in US emissions that BOEM's official Programmatic Environmental Impact Statement reports for its No Action Alternative (relative to the Proposed Program), which instead amount to just 0.13 billion, 0.12 billion and 0.013 billion tonnes CO_2 for the high, mid, and low-price scenarios, respectively. Those calculations *exclude* the far larger emissions attributable to the global market effect.[213]

If BOEM were to account for the effects of reducing U.S. oil production on international oil consumption, the global GHG impact of the No Action Alternative over the life of the 2017-2022 Program would be a decrease of up to 2.3 billion tonnes of CO_2 which is greater than a year's worth of emissions from the entire U.S. transportation section (i.e., 1.7 billion tonnes CO_2).

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[208] Unfortunately, in direct contradiction to its global oil market model results, BOEM erroneously concludes in this report that producing 3.7 billion barrels of oil would make no difference for GHG emissions, and would even reduce GHG emissions compared to the No Action alternative of no new leasing, by failing to account for the large-scale decrease in global oil consumption and the resulting enormous decrease in GHG pollution under the No Action Alternative. BOEM acknowledged that its GHG analysis was limited in "not fully capturing global market and GHG implications" (at Forward) and in not including the GHG savings from reduced global oil and gas consumption in its emissions estimate for the No Action Alternative (at page 23).

[209] *Id.* at Table 6-2. Table 6-2 estimates production from the Final Proposed Program with a range of 2.2 billion barrels for the low price scenario, 3.7 billion barrels for the mid-price scenario and 5.9 billion barrels for the high price scenario

[210] *Id. at* Table 6-2.

[211] *Id.* at 23.

[212] Erickson, Peter, Final Obama administration analysis shows expanding oil supply increases CO_2, Stockholm Environment Institute, January 30, 2017, at https://www.sei-international.org/fossil-fuels-and-climate-change/news-and-opinion/30--news-archive/3617-final-obama-administration-analysis-shows-expanding-oil-supply-increases-co2

[213] *Id.*

According to the IPCC Fifth Assessment (AR5), total cumulative anthropogenic emissions of CO_2 must remain below about 1,000 $GtCO_2$ (equal to 275 GtC) from 2011 onward for a 66 percent probability of limiting warming to 2°C above pre-industrial levels.[214] Specifically, the AR5 states that cumulative CO_2 emissions from all anthropogenic sources must stay below 1 trillion tons of carbon or 1000 GtC (equal to 3670 $GtCO_2$) from 1861-1880 onward for a >66 percent probability of limiting warming to less than 2°C.[215] The AR5 goes on to state that 1000 GtC is reduced to about 790 GtC (2900 $GtCO_2$) when accounting for non-CO_2 forcings. Furthermore, an amount of 515 GtC (1890 $GtCO_2$) was already emitted as of 2011. This leaves a carbon budget of 275 GtC or 1010 $GtCO_2$ from 2011 onward (i.e., 790 GtC minus 515 GtC leaves 275 GtC which equates to 1009 $GtCO_2$).

Given that global CO_2 emissions in 2015 alone totaled 9.8 GtC (36 $GtCO_2$),[216] this carbon budget is being rapidly consumed. The 275 GtC (1010 GtCO2) carbon budget from 2011 onward has been reduced to 232 GtC (850 $GtCO_2$) from 2015 onward.[217]

The cumulative lifecycle emissions from the Forest Service's plan to open the forest to leasing should be put in the context of the global and U.S. carbon budgets. The more than 101 million metric tons CO_2 that would result from leasing in the planning area is significant in the scope of national, state, and local level commitments to implementing rapid GHG emissions reductions. At a time when the U.S. must rapidly ratchet down GHG emissions to avoid the worst dangers of climate change, the Forest Service should not be committing to new fossil fuel development and infrastructure on our public lands that locks in carbon intensive oil production for years into the future.

A robust body of scientific research has established that most fossil fuels must be kept in the ground to avoid the worst dangers of climate change. Human-caused climate change is already causing widespread damage from intensifying global food and water insecurity, the increasing frequency of heat waves and other extreme weather events, flooding of coastal regions by sea level rise and increasing storm surge, the rapid loss of Arctic sea ice and Antarctic ice

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[214] Intergovernmental Panel on Climate Change, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F. et al. (eds.)], Cambridge University Press (2013) at 27; Intergovernmental Panel on Climate Change, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland, 151 pp. (2014) at 63-64 & Table 2.2.
[215] IPCC 2013 at 27 ("Limiting the warming caused by anthropogenic CO_2 emissions alone with a probability of >33%, >50%, and >66% to less than 2°C since the period 1861–1880, will require cumulative CO_2 emissions from all anthropogenic sources to stay between 0 and about 1570 GtC (5760 $GtCO_2$), 0 and about 1210 GtC (4440 $GtCO_2$), and 0 and about 1000 GtC (3670 $GtCO_2$) since that period, respectively. These upper amounts are reduced to about 900 GtC (3300 $GtCO_2$), 820 GtC (3010 $GtCO_2$), and 790 GtC (2900 $GtCO_2$), respectively, when accounting for non-CO_2 forcings as in RCP2.6. An amount of 515 [445 to 585] GtC (1890 [1630 to 2150] $GtCO_2$), was already emitted by 2011.").
[216] *See* Le Quéré, Corrine et al., Global Carbon Budget 2016, 8 Earth System Science Data 605 (2016).
[217] Rogelj, Joeri et al., Differences between carbon budget estimates unraveled, 6 Nature Climate Change 245 (2016) at Table 2.

shelves, increasing species extinction risk, and the worldwide collapse of coral reefs.[218] The Third National Climate Assessment makes clear that "reduc[ing] the risks of some of the worst impacts of climate change" will require "aggressive and sustained greenhouse gas emission reductions" over the course of this century.[219]

The United States has committed to the climate change target of holding the long-term global average temperature "to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels"[220] under the Paris Agreement.[221] The United States signed the Paris Agreement on April 22, 2016 as a legally binding instrument through executive agreement,[222] and the treaty entered into force on November 4, 2016. The Paris Agreement codifies the international consensus that climate change is an "urgent threat" of global concern.[223] The Agreement also requires a "well below 2°C" climate target because 2°C of warming is no longer considered a safe guardrail for avoiding catastrophic climate impacts and runaway climate change.[224]

Immediate and aggressive greenhouse gas emissions reductions are necessary to keep warming well below 2°C rise above pre-industrial levels. The IPCC Fifth Assessment Report and other expert assessments have established global carbon budgets, or the total amount of carbon that can be burned while maintaining some probability of staying below a given temperature target. According to the IPCC, total cumulative anthropogenic emissions of CO_2 must remain below about 1,000 $GtCO_2$ from 2011 onward for a 66 percent probability of limiting warming to 2°C above pre-industrial levels, and to 400 $GtCO_2$ from 2011 onward for a 66 percent

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[218] Melillo, Jerry M., Climate Change Impacts in the United States: The Third National Climate Assessment, Terese (T.C.) Richmond and Gary W. Yohe, Eds., U.S. Global Change Research Program, (2014); U.S. Global Change Research Program, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J. et al. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp. (2017).
[219] Melillo, Jerry M., Climate Change Impacts in the United States: The Third National Climate Assessment, Terese (T.C.) Richmond and Gary W. Yohe, Eds., U.S. Global Change Research Program, (2014) at 13, 14, and 649.
[220] United Nations Framework Convention on Climate Change, Conference of the Parties, Nov. 30-Dec. 11, 2015, Adoption of the Paris Agreement Art. 2, U.N. Doc. FCCC/CP/2015/L.9 (December 12, 2015) ("Paris Agreement").
[221] On December 12, 2015, 197 nation-state and supra-national organization parties meeting in Paris at the 2015 United Nations Framework Convention on Climate Change Conference of the Parties consented to the Paris Agreement committing its parties to take action so as to avoid dangerous climate change.
[222] United Nations Treaty Collection, Chapter XXVII, 7.d Paris Agreement, List of Signatories; U.S. Department of State, Background Briefing on the Paris Climate Agreement (December 12, 2015). Although not every provision in the Paris Agreement is legally binding or enforceable, the U.S. and all parties are committed to perform the treaty commitments in good faith under the international legal principle of *pacta sunt servanda* ("agreements must be kept"); Vienna Convention on the Law of Treaties, Article 26. Although the United States in June 2017 announced its intention to withdraw from the Paris Agreement, in accordance with article 28, such withdrawal cannot occur until November 4, 2020.
[223] *See* Paris Agreement, at Recitals.
[224] *See* the comprehensive scientific review under the United Nations Framework Convention on Climate Change (UNFCCC) of the global impacts of 1.5°C versus 2°C warming: U.N. Subsidiary Body for Scientific and Technological Advice, Report on the Structured Expert Dialogue on the 2013-2015 review, FCCC/SB/2015/1NF.1 (May 4,2015); *See also* Schleussner, Carl-Friedrich et al., Differential climate impacts for policy-relevant limits to global warming: the case of 1.5°C and 2°C, 7 Earth Systems Dynamics 327 (2016); Anderson, Kevin and Alice Bows, Beyond 'dangerous' climate change: emission scenarios for a new world, 369 Philosophical Transactions of the Royal Society 20 (2011).

probability of limiting warming to 1.5°C.[225] These carbon budgets have been reduced to 850 $GtCO_2$ and 240 $GtCO_2$, respectively, from 2015 onward.[226]

Published scientific studies have estimated the United States' portion of the global carbon budget by allocating the remaining global budget across countries based on factors including equity and economics. Estimates of the U.S. carbon budget vary depending on the temperature target used by the study (1.5°C versus 2°C), the likelihood of meeting the temperature target (50 or 66 percent probability), the equity principles used to apportion the global budget among countries, and whether a cost-optimal model was employed. The U.S. carbon budget for limiting temperature rise to well below 2°C has been estimated at 38 $GtCO_2$, while the estimated budget for limiting temperature rise to 2°C ranges from 34 $GtCO_2$ to 158 $GtCO_2$.

Du Pont et al. (2017) averaged across five IPCC-AR5 sharing principles (e.g. capability, equal per capita, greenhouse development rights, equal cumulative per capita, and constant emissions ratio) to estimate the U.S. carbon budget through 2100 based on a cost-optimal model.[227] Du Pont et al. (2017) estimated the U.S. carbon budget at 57 $GtCO_2eq$ (equal to ~ 38 $GtCO_2$)[228] for a 50 percent chance of returning global average temperature rise to 1.5°C by 2100, which is the only target among the studies that is consistent with the well below 2°C temperature commitment of the Paris Agreement. The U.S. carbon budget for a 66 percent probability of keeping warming below 2°C was estimated at 104 $GtCO_2eq$ (equal to ~ 69 $GtCO_2$).[229]

For a 66 percent probability of keeping warming below 2°C, Peters et al. (2015) estimated the U.S. carbon budget at 34 $GtCO_2$ based on an equity approach for allocating the global carbon budget, and 123 $GtCO_2$ under an inertia approach.[230] The "inertia" approach bases sharing on countries' current emissions, while the "equity" approach bases sharing on population size and provides for equal per-capita emissions across countries. Similarly using a 66 percent probability of keeping warming below 2°C, Gignac et al. (2015) estimated the U.S. carbon budget at 78 to 97 $GtCO_2$, based on a contraction and convergence framework, in which all countries adjust their emissions over time to achieve equal per-capita emissions.[231] Although the

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[225] Intergovernmental Panel on Climate Change, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F. et al. (eds.), Cambridge University Press (2013) at 27; Intergovernmental Panel on Climate Change, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland, 151 pp. (2014) at 63-64 & Table 2.2.
[226] Rogelj, Joeri et al., Differences between carbon budget estimates unraveled, 6 Nature Climate Change 245 (2016) at Table 2.
[227] Du Pont, Yann Robiou et al., Equitable mitigation to achieve the Paris Agreement goals, 7 Nature Climate Change 38 (2017).
[228] *See* Meinshausen, Malte et al., Greenhouse gas emission targets for limiting global warming to 2 degrees Celsius, 458 Nature 1158 (2009). We used a conversion factor of 1 $GtCO_2$ = 1.5 $GtCO_2eq$ based on Table 1 in Meinshausen et al. 2009.
[229] *Id.* 1 $GtCO_2$ = 1.5 $GtCO_2eq$ based on Table 1 in Meinshausen et al. 2009.
[230] Peters, Glen P. et al., Measuring a fair and ambitious climate agreement using cumulative emissions, 10 Environmental Research Letters 105004 (2015).
[231] Gignac, Renaud and H. Damon Matthews, Allocating a 2C cumulative carbon budget to countries, 10 Environmental Research Letters 075004 (2015). In a contraction and convergence approach, national emissions are

contraction and convergence framework corrects current emissions inequities among countries over a specified time frame, it does not account for inequities stemming from historical emissions differences. When accounting for historical responsibility, Gignac et al. (2015) estimated that the United States has an additional cumulative carbon debt of 100 $GtCO_2$ as of 2013. Using a non-precautionary 50 percent probability of limiting global warming to 2°C, Raupach et al. (2014) estimated the U.S. carbon budget at 158 $GtCO_2$ based on a "blended" approach of sharing principles that averages the "inertia" and "equity" approaches.[232] Of that 158 $GtCO_2$ budget, 91 $GtCO_2$ was categorized as "committed" emissions from existing CO_2-emitting infrastructure that will continue for infrastructure lifetimes without early retirement.[233] Under any scenario, the remaining U.S. carbon budget consistent with limiting global average temperature rise to 1.5°C or 2°C is extremely small and is rapidly being consumed.

Furthermore, a large body of scientific research has established that the vast majority of global and U.S. fossil fuels must stay in the ground in order to hold temperature rise to well below 2°C.[234] Studies estimate that 68 to 80 percent of global fossil fuel reserves must not be extracted and burned to limit temperature rise to 2°C based on a 1,000 $GtCO_2$ carbon budget.[235] For a 50 percent chance of limiting temperature rise to 1.5°C, 85 percent of known fossil fuel reserves must stay in the ground.[236] Effectively, fossil fuel emissions must be phased out globally within the next few decades.[237]

A 2016 global analysis found that potential carbon emissions from developed reserves in currently operating oil and gas fields and mines would lead to global temperature rise beyond 2°C.[238] Excluding coal, currently operating oil and gas fields alone would take the world beyond

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allowed to increase or decrease for some period of time until they converge to a point of equal per capita emissions across all regions at a given year, at which point all countries are entitled to the same annual per capita emissions.

[232] Raupach, Michael et al., Sharing a quota on cumulative carbon emissions, 4 Nature Climate Change 873 (2014) at Supplementary Figure 7.

[233] *Id.*

[234] The IPCC estimates that global fossil fuel reserves exceed the remaining 275 GtC carbon budget (from 2011 onward) for staying below 2°C by 4 to 7 times, while fossil fuel resources exceed the carbon budget for 2°C by 31 to 50 times. *See* Bruckner, Thomas et al., 2014: Energy Systems. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press (2014) at Table 7.2.

[235] To limit temperature rise to 2°C based on a 1,000 $GtCO_2$ carbon budget from 2011 onward, studies indicate variously that 80 percent (Carbon Tracker Initiative 2013), 76 percent (Raupach et al. 2014), and 68 percent (Oil Change International 2016) of global fossil fuel reserves must stay in the ground. *See* Carbon Tracker Initiative, Unburnable Carbon – Are the world's financial markets carrying a carbon bubble? (2013); Raupach et al. 2014; Oil Change International, The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production (September 2016).

[236] Oil Change International 2016 at 6.

[237] Rogelj et al. (2015) estimated that a reasonable likelihood of limiting warming to 1.5° or 2°C requires global CO_2 emissions to be phased out by mid-century and likely as early as 2040-2045. Rogelj, Joeri et al., Energy system transformations for limiting end-of-century warming to below 1.5°C, 5 Nature Climate Change 519 (2015). The United States must phase out fossil fuel CO_2 emissions even earlier: between 2025 and 2030 on average for a reasonable chance of staying below 1.5°C and between 2040 and 2045 on average for a reasonable chance of staying below 2°C. *See* Climate Action Tracker, USA (last updated Jan. 25, 2017) at Rating figure showing U.S. emissions versus year (last visited Nov. 13, 2017).

[238] Oil Change International (2016) at 5.

1.5°C.[239] To stay well below 2°C, the clear implication is that no new fossil fuel extraction or transportation infrastructure should be built, and governments should grant no new permits for new fossil fuel extraction and infrastructure.[240] Moreover, some fields and mines, primarily in rich countries, must be closed before fully exploiting their resources. The analysis concludes that, because existing fossil fuel reserves considerably exceed both the 2°C and 1.5°C carbon budgets, "[i]t follows that exploration for new fossil fuel reserves is at best a waste of money and at worst very dangerous."[241]

According to a U.S.-focused analysis,[242] the United States alone has enough recoverable fossil fuels, split about evenly between federal and non-federal resources, that if extracted and burned, would exceed the global carbon budget for a 1.5°C limit, and would consume nearly the entire global budget for a 2°C limit.[243] Specifically, the analysis found:

> Potential greenhouse gas emissions of federal fossil fuels (leased and unleased) if developed would release up to 492 $GtCO_2e$, representing 46 percent to 50 percent of potential emissions from all remaining U.S. fossil fuels.

Of that amount, up to 450 $GtCO_2e$ have not yet been leased to private industry for extraction; Releasing those 450 $GtCO_2e$ (the equivalent annual pollution of more than 118,000 coal-fired power plants) would be greater than any proposed U.S. share of global carbon limits that would keep emissions well below 2°C.[244]Fracking has also opened up vast resources that otherwise would not be available, increasing the potential for future greenhouse gas emissions.

In sum, the long-lived GHG emissions and fossil fuel infrastructure that would result from leasing in the planning area will contribute to undermining climate commitments and increasing climate change impacts, at a time when there is urgent need to keep most fossil fuels in the ground.

Finally, the EIS's climate change analysis should draw upon the 2017 National Climate Assessment's Climate Science Special Report.[245] Key points from this scientific report highlight the urgent need to reduce greenhouse gas emissions to avoid large and irreversible impacts:

- The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse gases (especially carbon dioxide) emitted globally. Without

[239] *Id.* at 5.
[240] *Id.* at 5.
[241] *Id.* at 17.
[242] Ecoshift Consulting, et al., The Potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels (2015).
[243] *Id.* at 4.
[244] Raupach, Michael et al. (2014) at Supplementary Figure 7. For the United States, Raupach et al. (2014) provided a mid-range estimate of the U.S. carbon quota of 158 $GtCO_2$ for a 50 percent chance of staying below 2°C, using a "blended" scenario of sharing principles for allocating the global carbon budget among countries. This study estimated U.S. fossil fuel reserves at 716 $GtCO_2$, of which coal comprises the vast majority, indicating that most fossil fuel reserves in the U.S. must remain unburned to meet a well below 2°C carbon budget.
[245] U.S. Global Change Research Program, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J. et al. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp. (2017).

major reductions in emissions, the increase in annual average global temperature relative to preindustrial times could reach 9°F (5°C) or more by the end of this century. With significant reductions in emissions, the increase in annual average global temperature could be limited to 3.6°F (2°C) or less.

- The global atmospheric carbon dioxide (CO2) concentration has now passed 400 parts per million (ppm), a level that last occurred about 3 million years ago, when both global average temperature and sea level were significantly higher than today. Continued growth in CO2 emissions over this century and beyond would lead to an atmospheric concentration not experienced in tens to hundreds of millions of years. There is broad consensus that the further and the faster the Earth system is pushed towards warming, the greater the risk of unanticipated changes and impacts, some of which are potentially large and irreversible.[246]

2. The Forest Service Must Provide a Meaningful Qualitative Analysis

Greenhouse gas emissions from leasing and development of unconventional wells could exact extraordinary financial costs to communities and future generations, setting aside the immeasurable loss of irreplaceable, natural values that can never be recovered. The Forest Service and BLM must provide an accounting of these potential costs in an EIS. The NEPA analysis should therefore put the proposed action's emissions into context using an evaluation of the proposed action's social cost of carbon ("SCC"). The Federal social cost of carbon, which multiple Federal agencies have developed and used to assess the costs and benefits of alternatives in rulemakings, offers a harmonized, interagency metric that can provide decisionmakers and the public with some context for meaningful NEPA review.[247] The SCC evaluation is a simple tool that contextualizes emissions by translating tons of carbon into estimates of the costs to society of emitting that carbon.

The effects of cumulative greenhouse gas emissions will have far-reaching impacts on and inflict extraordinary harm to natural and social systems. The agencies must provide meaningful analysis of the proposed action's contribution to these effects. The Paris Agreement codified the international consensus that the climate crisis is an urgent threat to human societies and the planet, with the parties recognizing that:

> Climate change represents an *urgent and potentially irreversible threat to human societies and the planet* and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions (emphasis added).[248]

Numerous authoritative scientific assessments have established that climate change is causing grave harms to human society and natural systems, and these threats are becoming

[246] *Id.* at 11.
[247] *See* "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis," (November 2013).
[248] Paris Agreement, Decision, Recitals.

increasingly dangerous. The Intergovernmental Panel on Climate Change (IPCC), in its 2014 Fifth Assessment Report, stated that: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased" and that "[r]ecent climate changes have had widespread impacts on human and natural systems."[249]

The 2014 Third National Climate Assessment, prepared by a panel of non-governmental experts and reviewed by the National Academy of Sciences and multiple federal agencies similarly stated that "[t]hat the planet has warmed is 'unequivocal,' and is corroborated though multiple lines of evidence, as is the conclusion that the causes are very likely human in origin,"[250] and "[i]mpacts related to climate change are already evident in many regions and are expected to become increasingly disruptive across the nation throughout this century and beyond."[251] The United States National Research Council similarly concluded that: "[c]limate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems."[252]

The IPCC and National Climate Assessment further decisively recognize the dominant role of fossil fuels in driving climate change:

> While scientists continue to refine projections of the future, observations unequivocally show that climate is changing and that the warming of the past 50 years is primarily due to human-induced emissions of heat-trapping gases. These emissions come mainly from burning coal, oil, and gas, with additional contributions from forest clearing and some agricultural practices.[253]
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> CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% to the total GHG emission increase between 1970 and 2010, with a contribution of similar percentage over the 2000–2010 period (*high confidence*).[254]

These impacts ultimately emanating from the extraction and combustion of fossil fuels

[249] IPCC AR5 Synthesis Report at 2.
[250] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., Climate Change Impacts in the United States: The Third National Climate Assessment (U.S. Global Change Research Program), doi:10.7930/J0Z31WJ2 (2014) ("Third National Climate Assessment") at 61 (quoting IPCC, Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, Eds., Cambridge University Press (2007).

[251] Third National Climate Assessment at 10.

[252] National Research Council, Advancing the Science of Climate Change (2010), available at www.nap.edu. ("Advancing the Science of Climate Change") at 2.
[253] Third National Climate Assessment at 2.
[254] IPCC AR5 Synthesis Report at 46.

are harming the United States in myriad ways, with the impacts certain to worsen over the coming decades absent deep reductions in domestic and global GHG emissions. EPA recognized these threats in its 2009 Final Endangerment Finding under Clean Air Act Section 202(a), concluding that greenhouse gases from fossil fuel combustion endanger public health and welfare: "the body of scientific evidence compellingly supports [the] finding" that "greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare."[255] In finding that climate change endangers public health and welfare, EPA has acknowledged the overwhelming evidence of the documented and projected effects of climate change upon the nation:

Effects on air quality: "The evidence concerning adverse air quality impacts provides strong and clear support for an endangerment finding. Increases in ambient ozone are expected to occur over broad areas of the country, and they are expected to increase serious adverse health effects in large population areas that are and may continue to be in nonattainment. The evaluation of the potential risks associated with increases in ozone in attainment areas also supports such a finding."[256]

Effects on health from increased temperatures: "The impact on mortality and morbidity associated with increases in average temperatures, which increase the likelihood of heat waves, also provides support for a public health endangerment finding."[257]

Increased chance of extreme weather events: "The evidence concerning how human induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be adversely affected by an increase in the severity of coastal storm events due to rising sea levels."[258]

Impacts to water resources: "Water resources across large areas of the country are at serious risk from climate change, with effects on water supplies, water quality, and adverse effects from extreme events such as floods and droughts. Even areas of the country where an increase in water flow is projected could face water resource problems from the supply and water quality problems associated with temperature increases and precipitation variability, as well as the increased risk of serious adverse effects from extreme events, such as floods and drought. The severity of risks and impacts is likely to increase over time with accumulating greenhouse gas concentrations and associated temperature increases."[259]

Impacts from sea level rise: "The most serious potential adverse effects are the increased risk of storm surge and flooding in coastal areas from sea level rise and more intense storms.

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[255] U.S. Environmental Protection Agency, Endangerment and Cause or Contribute Findings for Greenhouse Gas Unders Section 202(a) of the Clean Air Act, 74 Fed. Reg. at 66,497 (Dec 15, 2009) ("Final Endangerment Finding").
[256] *Id.*
[257] *Id.*
[258] *Id.* at 66,497-98.
[259] *Id.* at 66,498.

Observed sea level rise is already increasing the risk of storm surge and flooding in some coastal areas. The conclusion in the assessment literature that there is the potential for hurricanes to become more intense (and even some evidence that Atlantic hurricanes have already become more intense) reinforces the judgment that coastal communities are now endangered by human-induced climate change, and may face substantially greater risk in the future. Even if there is a low probability of raising the destructive power of hurricanes, this threat is enough to support a finding that coastal communities are endangered by greenhouse gas air pollution. In addition, coastal areas face other adverse impacts from sea level rise such as land loss due to inundation, erosion, wetland submergence, and habitat loss. The increased risk associated with these adverse impacts also endangers public welfare, with an increasing risk of greater adverse impacts in the future."[260]

Impacts to energy, infrastructure, and settlements: "Changes in extreme weather events threaten energy, transportation, and water resource infrastructure. Vulnerabilities of industry, infrastructure, and settlements to climate change are generally greater in high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate-sensitive resources. Climate change will likely interact with and possibly exacerbate ongoing environmental change and environmental pressures in settlements, particularly in Alaska where indigenous communities are facing major environmental and cultural impacts on their historic lifestyles."[261]

Impacts to wildlife: "Over the 21st century, changes in climate will cause some species to shift north and to higher elevations and fundamentally rearrange U.S. ecosystems. Differential capacities for range shifts and constraints from development, habitat fragmentation, invasive species, and broken ecological connections will likely alter ecosystem structure, function, and services, leading to predominantly negative consequences for biodiversity and the provision of ecosystem goods and services."[262]

In addition to these acknowledged impacts on public health and welfare more generally, climate change is causing and will continue to cause serious impacts on natural resources that the Department of Interior is specifically charged with safeguarding.[263]

Impacts to Public Lands: Climate change is causing and will continue to cause specific impacts to public lands ecosystem services. Although public lands provide a variety of difficult-to-quantify public benefits, one recent Forest Service attempt at quantification estimates the public land ecosystem services at risk from climate change at between $14.5 and $36.1 billion annually.[264] In addition to the general loss of ecosystem services, irreplaceable species and aesthetic and recreational treasures are at risk of permanent destruction. High temperatures are

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[260] *Id.*
[261] *Id.*
[262] *Id.*; *see also* Third National Climate Assessment at 195-219.
[263] *See* Federal Land Policy and Management Act of 1976, 43 U.S.C. §§ 1701(a)(8), 1712(c)(1); Multiple-Use Sustained Yield Act of 1960, 16 U.S.C. § 528; National Environmental Policy Act of 1969, 42 U.S.C. §§ 4331-4332.
[264] Esposito, Valerie et al., Climate Change and Ecosystem Services: The Contribution and Impacts on Federal Public Lands in the United States, USDA Forest Service Proceedings RMRS-P-64 at 155-164 (2011).

causing loss of glaciers in Glacier National Park; the Park's glaciers are expected to disappear entirely by 2030, with ensuing warming of stream temperatures and adverse effects to aquatic ecosystems.[265] With effects of warming more pronounced at higher latitudes, tundra ecosystems on Alaska public lands face serious declines, with potentially serious additional climate feedbacks from melting permafrost.[266] In Florida, the Everglades face severe ecosystem disruption from already-occurring saltwater incursion.[267] Sea level rise will further damage freshwater ecosystems and the endangered species that rely on them.

Impacts to Biodiversity and Ecosystems: Across the United States ecosystems and biodiversity, including those on public lands, are directly under siege from climate change—leading to the loss of iconic species and landscapes, negative effects on food chains, disrupted migrations, and the degradation of whole ecosystems.[268] Specifically, scientific evidence shows that climate change is already causing changes in distribution, phenology, physiology, genetics, species interactions, ecosystem services, demographic rates, and population viability: many animals and plants are moving poleward and upward in elevation, shifting their timing of breeding and migration, and experiencing population declines and extirpations.[269] Because climate change is occurring at an unprecedented pace with multiple synergistic impacts, climate change is predicted to result in catastrophic species losses during this century. For example, the IPCC concluded that 20% to 30% of plant and animal species will face an increased risk of extinction if global average temperature rise exceeds 1.5°C to 2.5°C relative to 1980-1999, with an increased risk of extinction for up to 70% of species worldwide if global average temperature exceeds 3.5°C relative to 1980-1999. [270]

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[265] U.S. Environmental Protection Agency, Climate Change and Public Lands (1999).

[266] *See* National Climate Assessment at 48; Collins, M. et al., Long-term Climate Change: Projections, Commitments and Irreversibility, Ch 12 at 1096-7 in *Climate Change 2013: The Physical Science Basis, Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2013); MacDougall, A. H., et al., Significant contribution to climate warming from the permafrost carbon feedback, 5 Nature Geoscience 719-721 (2012), doi:10.1038/ngeo1573.

[267] *See* National Climate Assessment at 592; Foti, Romano et al., Signs of critical transition in the Everglades wetlands in response to climate and anthropogenic changes, 110 Proceedings of the National Academy of Sciences6296-6300, (2013), doi:10.1073/pnas.1302558110.

[268] National Climate Assessment at 13.

[269] *See* Parmesan, C. and G. Yohe, A globally coherent fingerprint of climate change impacts across natural systems, 421 Nature 37–42 (2003); Root, T. et al., Fingerprints of global warming on wild animals and plants, 421 Nature 57–60 (2003); Chen, I. et al., Rapid range shifts of species associated with high levels of climate warming, 333 Science 1024–1026 (2011).

[270] Intergovernmental Panel on Climate Change, Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, Eds., Cambridge University Press (2007). Other studies have predicted similarly severe losses: 15%-37% of the world's plants and animals committed to extinction by 2050 under a mid-level emissions scenario, s*ee* Thomas et al., Extinction risk from climate change, 427 Nature 145–8 (2004)); the potential extinction of 10% to 14% of species by 2100 if climate change continues unabated, *see* Maclean, I. M. D. and R. J. Wilson, Recent ecological responses to climate change support predictions of high extinction risk, 108 Proceedings of the National Academy of Sciences of the United States of America 12337-12342 (2011); and the loss of more than half of the present climatic range for 58% of plants and 35% of animals by the 2080s under the current emissions pathway, in a sample of 48,786 species, *see* Warren, R. J. et al., Increasing Impacts of Climate Change Upon Ecosystems with Increasing Global Mean Temperature Rise, 106 Climatic Change 141–77 (2011)..

Although cost-benefit analysis is not necessarily the ideal or exclusive method for assessing contributions to an adverse effect as enormous, uncertain, and potentially catastrophic as climate change, BLM does have tools available to provide one approximation of external costs and has previously performed a "social cost of carbon" analysis in prior environmental reviews.[271] Its own internal memo identifies one available analytical tool: "For federal agencies the authoritative estimates of [social cost of carbon] are provided by the 2013 technical report of the Interagency Working Group on Social Cost of Carbon, which was convened by the Council of Economic Advisers and the Office of Management and Budget."[272] As explained in that report:

> The purpose of the "social cost of carbon" (SCC) estimates presented here is to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions into cost-benefit analyses of regulatory actions that impact cumulative global emissions. The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.[273]

Further, other analytical tools exist to evaluate the cost of methane emissions.[274] EPA has peer reviewed and employed such a tool in its "Regulatory Impact Analysis of the Proposed Emission Standards for New and Modified Sources in the Oil and Natural Gas Sector."[275]

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[271] *See High Country Conserv'n Advocates v. United States Forest Serv.*, 2014 U.S. Dist. Lexis 87820 (D. Colo. 2014) (invalidating environmental assessment ["EA"] for improperly omitting social cost of carbon analysis, where BLM had included it in preliminary analysis); Taylor, P. "BLM crafting guidance on social cost of carbon -- internal memo," Greenwire, April 15, 2015, available at http://www.eenews.net/greenwire/stories/1060016810/; BLM Internal Memo from Assistant Director of Resources and Planning Ed Roberson ("Roberson Internal Memo"), April 2015, available at http://www.eenews.net/assets/2015/04/15/document_gw_01.pdf (noting "some BLM field offices have included estimates of the [social cost of carbon] in project-level NEPA documents") (accessed July 29, 2015); *see also* Council on Environmental Quality, Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts, p. 18, available at www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance (accessed Jul 29, 2015) (quantitative analysis required if GHGs > 25k tons/yr).

[272] BLM, Roberson Internal Memo.

[273] *See* Interagency Working Group on Social Cost of Carbon, United States Government, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866, May 2013, available at https://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf (accessed July 29, 2015).

[274] *See* Marten A.L., Kopits K.A., Griffiths C.W., Newbold S.C., Wolverton A. 2014, online publication (2015, print publication). "Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO2 estimates," Climate Policy 15(2):272-298, abstract available at http://www.tandfonline.com/doi/abs/10.1080/14693062.2014.912981.

[275] *See* U.S. Environmental Protection Agency, Social Cost of Carbon, *available at* http://www3.epa.gov/climatechange/EPAactivities/economics/scc.html (noting application of social cost of methane supported by peer review); USEPA, Regulatory Impact Analysis of the Proposed Emission Standards for New and Modified Sources in the Oil and Natural Gas Sector, Ch. 4, available at http://www3.epa.gov/airquality/oilandgas/pdfs/og_prop_ria_081815.pdf.

In sum, climate change, driven primarily by the combustion of fossil fuels, poses a severe and immediate threat to the health, welfare, ecosystems and economy of the United States. These impacts are felt across the nation, including upon the public lands the Secretary of the Interior is charged with safeguarding. Social cost of carbon analysis is an appropriate tool for analyzing the cumulative impacts of greenhouse gas emissions, and a rapid and deep reduction of emissions generated from fossil fuels is essential if such threats are to be minimized and their impacts mitigated.

3. The Forest Service Should Consider a Carbon-Constrained Alternative

In light of the foregoing information, the Forest Service should consider a "carbon-constrained" alternative that sets a quantitative limit on the amount of GHG emissions allowable from oil and gas development within the planning area; or, that provides measures to significantly limit GHG emissions from oil and gas development. The following measures could be adopted as part of this alternative:

- A commitment to net zero emissions from all oil and gas development or all activities in the planning area;
- A ban on new oil and gas leasing in the planning area;
- A ban on fracking throughout the planning area;
- A ban on new fossil fuel infrastructure throughout the planning area (e.g, pipelines, roads, or right-of-ways);
- A program to buy existing leases on NFGT lands;
- A program to require offsets for lifecycle GHG emissions from oil and gas leases in the planning area;
- A program to require methane and other GHG reduction measures, such as closed loop systems, energy efficiency measures, renewable power, leak detection, and carpooling.

Attachment A provides additional information on the need to drastically and immediately reduce carbon emissions and avoid carbon "lock-in" to avert the worst effects of climate change. The Forest Service should weigh the best available science in weighing a carbon-constrained alternative.

E. The Forest Service Must Fully and Accurately Analyze the Surface Disturbance Impacts from Oil and Gas Development

Opening oil and gas leasing in the NFGT will likely result in significant surface impacts from new drilling and hydraulic fracturing—the amount and nature of which have not been adequately examined in BLM's 2018 Reasonable Foreseeable Development Scenario for Oil and Gas Activities (RFDS) for the NFGT.

The RFDS provided a summary of a 20 year estimated federal surface disturbance for the period of 2018-2037; it "estimate[s] an additional 2,300 acres of disturbance, which includes both new wells and new disturbance on existing well pads, for a maximum potential disturbance of 4,000 acres during the planning period [when accounting for 1,700 acres of existing disturbance]. It is expected that 2,500 acres of surface disturbance will remain at the end of the planning period."[276]

Within the proclamation boundary for the NFGT (including both federal and private lands), the RFDS estimates an additional 7,100 acres of disturbance on top of 6,800 acres of existing disturbance in the NFGT for a maximum potential of 13,900 acres of disturbance during the planning period.[277] Further, "[a]ccounting for interim and final reclamation, [BLM] expect[s] 8,200 acres of surface disturbance to remain at the end of the planning period."[278]

Within the Local Analysis Area for the NFGT, which includes the entire area within the proclamation boundary plus lands within a 1.5-mile radius of the proclamation boundary, the total maximum disturbance is expected to be 20,800 acres, of which 9,700 acres is already existing disturbance and of which 11,100 acres is new disturbance).[279] BLM expects 16,000 acres of surface disturbance to remain at the end of the planning period, after interim and final reclamation.[280]

The following values below were used for estimating existing and projected surface disturbance.[281]

Parameter	Value
Well pad area during drilling and completion	5 acres
Surface disturbance per well pad due to roads and flow lines	0.6 acres
Estimated additional surface disturbance per well pad	0.25 acres
Horizontal well pad area after interim reclamation	2.2 acres
Vertical well pad area after interim reclamation	0.75 acres

The RFDS does not clearly or fully discuss how BLM came to the values listed above, along with the total number of wells that would be developed throughout the planning area. The Forest Service (FS) must show and explain how the RFDS arrived at those values so the public can understand whether they are reasonable estimates. The RFDS also needs to explain the labeled parameters, e.g. "estimated additional surface disturbance," which is undefined. The language in the RFDS must be descriptive enough so the public understands the terminology and the methodology for estimating surface disturbance and can have an opportunity to meaningfully comment on the methodology and estimates. Agency NEPA documents should allow the public insight into the environmental impacts analysis and planning process; it is important that the Forest Service ensures the RFDS fully and accurately analyze the projected surface disturbance, which will form the basis for the Forest Service's analysis of how its oil and gas leasing plan will impact public lands, wildlife, and other resources.

[276] Crocker, Kelsey and James F. Glover, Reasonable Foreseeable Development Scenario for Oil and Gas Activities, National Forests and Grasslands in Texas (Nov. 2018) at 15.
[277] *Id.*
[278] *Id.*
[279] *Id.*
[280] *Id.*
[281] *Id.* at 16.

The RFDS does a cursory review of surface disturbance neglecting to mention other sources of surface disturbance. The document fails to analyze or reference other disturbances, e.g. staging areas, gathering lines, pipelines, surface impoundments, and compressor stations. The only gas transport lines mentioned in the RFDS are "flow lines," which do not necessarily encompass gathering lines and transmission pipelines, as they serve different functions.[282] "The well flowline, or simply flowline, is the first 'pipeline' system connected to the wellhead. The flowline carries total produced fluids (e.g., oil, gas, and production water) from the well to the first piece of production equipment—typically a production separator. The flowline may carry the well-production fluids to a common production battery, a gathering pipeline system, process facility, or other."[283] "The pipe that delivers the well production to some intermediate or terminal location is the gathering or sales pipeline. The gathering pipeline literally 'gathers' the production from producing wells and conveys the production to a collection system, a processing facility, custody-transfer (sales) point, or other."[284] "The transmission pipeline is a 'cross-country' pipeline that is specifically designed to transport petroleum products long distances. The transmission pipeline collects the specific petroleum products from many "supply" sources along the pipeline (such as gathering pipelines) and 'delivers' the product to one or more end users."[285] The RFDS fails to address whether gathering lines or transmission lines will be required within the planning area. Pipelines, including gathering lines, have

In addition, the RFDS fails to address potential surface disturbance from staging areas and their access roads, which may needed for construction of pipelines or well pads. Staging areas are strategically located along the planned right-of-way (ROW), which are cleared out and covered with rough stone gravel and reinforced with timber matting.[286] For pipelines staging areas is where equipment is stored and pipe is stockpiled. Staging areas can be located in remote areas (e.g., fields, forests, pasture) so paved roads are constructed to allow trucks and equipment access to the pipeline ROW.[287] "The width of the right-of-way is determined based on the diameter of the pipe (8-41 inches), with widths ranging from 80-125."[288] Once the staging areas are staged and accessible, construction begins.

The RFDS's failure to fully account for all surface disturbance for the development of a well site could result in significant underestimates of surface disturbance per well site and cumulatively forest-wide. According to a 2015 analysis of the areas of the Marcellus Shale in Pennsylvania most suitable for fracking, the development of natural gas infrastructure results in 17 to 23 acres of land cover disturbance per well pad. [289] In the Marcellus Shale, this amount of

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[282] PetroWiki, Piping and pipelines systems, (Last modified June 2, 2015) (Accessed on November 26, 2019), available at: https://petrowiki.org/Piping_and_pipeline_systems.
[283] *Id.*
[284] *Id.*
[285] *Id.*
[286] Fractracker Alliance, Pipeline Construction: Step By Step Guide, available at: https://www.fractracker.org/resources/oil-and-gas-101/pipeline-construction/ (Accessed on November 26, 2019).
[287] *Id.*
[288] *Id.*
[289] Environment America Report at 15.

surface disturbance could reduce the amount of interior forest, at least 300 feet from the forest edge, by 5 to 10 percent across the region studied.[290]

The RFDS should provide region-specific analyses of projected surface disturbance from well sites. A draft Bureau of Reclamation study addressing the effects of oil and gas development proposed around Choke Canyon Reservoir and best management practices to mitigate those effects, provides detailed figures as to typical well pad size, surface disturbance, horizontal well bore lengths and orientation, and water use in the Eagle Ford Shale.[291] Similar data and figures should be available for the Barnett and Hayesville shale plays and/or the NFGT.

The failure to clearly and accurately identify the amount of surface disturbance from each well site and explain how the FS arrived at these figures will infect the FS's analysis of numerous impacts, including impacts on vegetation, wildlife, scenic resources, land use, and water resources. FS must revise the RFDS to clearly and fully identify the type and amount of surface disturbance that would result from the proposed oil and gas leasing plan.

F. The Forest Service Must Analyze the Impacts of Oil and Gas Development on Biological Resources

A number of biological resources will be impacted by increased fracking throughout the forest, including the endangered red-cockaded woodpecker and other sensitive species, and important ecological services provided by the forest.

1. The EIS Must Analyze the Impact of Forest Fragmentation and Fracking on the Red-cockaded Woodpecker and other Sensitive Forest Species

The red-cockaded woodpecker (RCW) is an endangered species with population numbers still decreasing. It is estimated the current population is fewer than 10,000.[292] The RCW habitat is located in the southeastern United States, including large areas of the Texas National Forests in east Texas. The species' declining population trend is due to forest removal, which has resulted in habitat loss and fragmentation.[293] "[In the] U.S. from [east] Texas to Maryland, the Red-cockaded Woodpecker has declined to as few as 10,000 birds and populations are highly fragmented."[294] RCWs' ideal habitat for nesting would consist of "mature pine woods (trees 80-100 or more years old), with very open understory maintained by frequent fires (the pines are fire-resistant)."[295] The species commonly inhabit longleaf pines, but can be found in other

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[290] *Id.*
[291] U.S. Bureau of Reclamation, [Draft Final] Best Management Practices: Hydrocarbon Exploration, Development, and Production at Nueces River Project, Choke Canyon Reservoir, Texas, Chapter 1 (Aug. 2015) ("BoR Study").
[292] Kaufman, Kenn, Red-cockaded Woodpecker, Audubon (2019) available at: https://www.audubon.org/field-guide/bird/red-cockaded-woodpecker (Accessed on Oct. 10, 2019) ("Audubon 2019").
[293] Conner, Richard N. and D. Craig Rudolph, Forest Habitat Loss, Fragmentation, and Red-Cockaded Woodpecker Populations, 103 The Wilson Bulletin 3 (1991) at 446.
[294] Arnold, Keith A., Red-Cockaded Woodpecker, The Texas Breeding Bird Atlas, Texas A&M AgriLife Extension, available at: https://txtbba.tamu.edu/species-accounts/red-cockaded-woodpecker/(Accessed on October 15, 2019) ("Texas Breeding Atlas").
[295] Audubon (2019).

pines.[296] Because of habitat loss and fragmentation, "the birds are now often found in mature loblolly, slash, shortleaf, Virginia, pond, and pitch pine forests. The woodpeckers are sometimes found in younger stands or stands with dense hardwood encroachment."[297]

The RCW occupies four national forests (Davy Crockett, Sam Houston, Angelina, and Sabine) in the southern region of Texas.[298] The national forests are home to upland pine woodlands and savanna ecosystems, which are primarily used for the recovery of the red-cockaded woodpecker.[299] RCWs are the only woodpeckers that like to bore their cavities in living pine trees.[300] "Old growth long-leaf pine…is favored where it occurs, but Red-cockaded Woodpeckers also use short-leaf…and loblolly pine…in Texas…."[301] "The older pines favored by the red-cockaded woodpecker often suffer from a fungus called red heart disease which attacks the center of the trunk, causing the inner wood, the heartwood, to become soft. Cavity excavation takes one to six years."[302] "The aggregate of cavity trees is called a cluster and may include 1 to 20 or more cavity trees on 3 to 60 acres."[303] A cluster is approximately 10 acres, with 10-30 mature pines.[304] The active tree cavities have resin wells that exude sap; the sap is used by the RCW as a defense mechanism.[305] The flowing sap prevents tree climbing snakes and other predators from invading RCW cavity nests.

This endangered woodpecker is considered a territorial non-migratory bird. Their social system is more complex than other bird species because individual birds live in family groups.[306] "The Red-cockaded Woodpecker is a cooperative breeder: it lives in small family groups of one breeding pair and several helpers. The extra birds usually are sons from previous breeding seasons (daughters rarely stay with their parents). The helpers assist in incubation, brooding, and feeding."[307] The family group territory "ranges from about 125 to 200 acres, but observers have reported territories running from a low of around 60 acres, to an upper extreme of more than 600

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[296] *Id.*
[297] All About Birds, Red-cocked woodpecker Overview, The Cornell Lab of Ornithology (2017), available at: https://www.allaboutbirds.org/guide/Red-cockaded_Woodpecker/lifehistory#behavior (Accessed on Oct. 10, 2019) ("Cornell Lab of Ornithology Overview").
[298] U.S. Dept. of Agriculture & U.S. Forest Service Southern Region, Final Environmental Impact Statement (FEIS) for the Revised Land Resource Management Plan, National Forests and Grasslands in Texas (1996) at 89 ("FEIS 196").
[299] U.S. Dept. of Agriculture & U.S. Forest Service Southern Region, Revised Land and Resource Management Plan, National Forests and Grasslands in Texas (1996) at 96.
[300] U.S. Fish and Wildlife Service, Red-Cockaded Woodpecker Recovery, available at: https://www.fws.gov/rcwrecovery/rcw.html (Last updated on Sept. 20, 2019) (Accessed on Oct. 10, 2019) ("RCW Recovery").
[301] Texas Breeding Atlas.
[302] *Id.*
[303] RCW Recovery.
[304] Texas Parks and Wildlife Department, Red-cockaded Woodpecker, available at: https://tpwd.texas.gov>pwd-bk-w7000-0013-red-cockaded-woodpecker (Accessed on Oct. 10, 2019).
[305] *Id.*
[306] Texas Breeding Atlas.
[307] All About Birds, Red-cocked woodpecker Overview, The Cornell Lab of Ornithology (2017), available at: https://www.allaboutbirds.org/guide/Red-cockaded_Woodpecker/lifehistory#behavior (Accessed on Oct. 10, 2019) ("Cornell Lab of Ornithology Life History").

acres. The size of a particular territory is related to both habitat suitability and population density."[308]

Much of the RCW habitat has been destroyed due to pine forest logging and the suppression of natural fires.[309] The Ecology of the Red-Cockaded Woodpecker describes fragmentation effect on the species:

> The fragmentation of the red-cockaded woodpecker's habitat is occurring at several different levels. At the regional level land use changes are causing the birds to disappear from private lands and leaving widely separated national forest islands as the only areas of livable habitat. Within the national forest landscape, the woodpecker subpopulations are further fragmented by small holdings of private land, water bodies, riverine hardwood forests, or large regenerated areas too young to support the birds. Finally, within the thousand-acre national forest compartments, clearcutting practices restrict the birds to tiny islands, narrow peninsulas, or other limited areas.[310]

Habitat fragmentation has a negative impact on RCW populations because distance is created between populations and subpopulations. "Openings within forest tracts further aggravated the isolation of woodpecker groups from each other within populations…When distances between groups became too great…isolated groups and populations disappeared."[311] Forest loss and habitat fragmentation is a result of clearcutting and forest management, which is doubly hard on RCW populations. It is doubly hard on the woodpeckers' population because, one, it physically reduces habitat available to the birds, limiting their territory and reducing their food resources. Two, it attracts new species which create competition for nesting cavities.[312] Under the current NFGT Forest Plan, oil and gas leasing is allowed within RCW habitat. The 1996 NFGT FEIS states "the areas in MA-2 are available for leasing, but due to the proximity to clusters there may be added stipulations for surface use."[313] It appears from the Notice of Intent, the Forest Service intends to continue keep RCW habitat open to leasing, but will consider revised stipulations for RCW habitat. Although there will be stipulations on any oil and gas activities in management area 2, clearcutting for oil and gas activities still creates a significant negative impact on RCW habitat, which is already severely diminished. If RCW habitat is disturbed or cut down the woodpecker abandons their territory after a short period.[314] Therefore, FS should consider in the EIS an alternative that does not allow oil and gas activities in RCW habitat.

Many studies have found that the construction of well pads, roads, pipelines, wastepits, seismic lines, and other infrastructure from oil and gas development has led to massive habitat loss and fragmentation in areas where fracking and other oil and gas development has

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[308] RCW Recovery.
[309] Audubon 2019.
[310] McFarlane, Robert W., A Stillness in the Pines: The Ecology of the Red-Cockaded Woodpecker, Commonwealth Fund Book Program (1992) at 164-165 ("A Stillness in the Pines").
[311] Conner, Richard N. et al., The Red-cockaded Woodpecker: Surviving in a Fire-Maintained Ecosystem, University of Texas Press (2001) at 8.
[312] A Stillness in the Pines at 167.
[313] FEIS 1996 at 93.
[314] Cornell Lab of Ornithology Life History.

proliferated. Habitat loss and fragmentation negatively affect species by reducing home range size, reducing patch size below what is needed for foraging and life history activities, increasing habitat isolation, altering physical characteristics such as light, moisture, and temperature, facilitating the spread of invasive species, and altering species dynamics, including movement patterns, interactions, and abundance.[315]

A review by Souther et al. (2014) of the biotic impacts of fracking identified key harms from habitat loss and fragmentation; surface and groundwater contamination; diminished stream flow; stream siltation; localized air, noise, and light pollution; climate change; and cumulative impacts.[316] Brittingham et al. (2014) reviewed current knowledge of the effects of hydraulic fracking on terrestrial and aquatic ecosystems in the United States, and identified numerous ecological impacts including habitat fragmentation, human disturbance, noise pollution, decreases in water quality and quantity, and cumulative effects on habitats and species of concern, all of which were expected to increase in magnitude as shale resource development continues to expand. The review concluded that species and habitats at particular risk include those with extensive overlap between a species' range or habitat type and a shale play, as well as those with limited ranges, small population size, specialized habitat requirements, and high sensitivity to disturbance such as core forest habitat and forest specialists, sagebrush habitat and specialists, vernal pond inhabitants, and stream species. Kiviat (2013) identified the ecological impacts from fracking in the Marcellus and Utica shale plays, including pollution by toxic synthetic chemicals, salt, and radionuclides; landscape fragmentation by well pads, pipelines, and roads; alteration of stream and wetland hydrology; and increased truck traffic.[317] The study highlighted particularly vulnerable groups, such as freshwater species (e.g., brook trout, freshwater mussels), fragmentation-sensitive species (e.g., forest-interior breeding birds, forest orchids), and species with restricted geographic ranges (e.g., Wehrle's salamander, tongue-tied minnow).

A U.S. Forest Service scientific team documented the impacts of natural gas development on the natural and scientific resources of the Fernow Experimental Forest in West Virginia where fracking a natural gas well occurred between 2007 and 2009.[318]

The observed impacts that were expected included (1) the permanent deforestation of the well pad, access road, and pipeline right of way; (2) the reshaping and contouring of the site which led to the removal of all ground vegetation within the perimeter and ground disturbance; and (3) significant soil erosion associated with the construction (an "underestimate" of 2.1 metric tons of eroded material per hectare was provided). The pipeline introduced 3,000 meters of hard edge; that increased fragmentation is likely to change the microclimate, and may change rates of

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[315] Brittingham, M.C., et al., Ecological risks of shale oil and gas development to wildlife, aquatic resources and their habitats, Environmental Science and Technology 48: 11034-11047 (2014) ("Brittingham 2014").
[316] Souther, S., et al., Biotic impacts of energy development from shale: research priorities and knowledge gaps, Frontiers in Ecology and the Environment 12: 330-338 (2014) ("Souther 2014").
[317] Kiviat, E., Risks to biodiversity from hydraulic fracturing for natural gas in the Marcellus and Utica shales, Annals of the New York Academy of Sciences 1286: 1-14 (2013) ("Kiviat 2013").
[318] Adams, M.B., et al., Effects of development of a natural gas well and associated pipeline on the natural and scientific resources of the Fernow Experimental Forest, U.S. Department of Agriculture Forest Service, Northern Research Station, General Technical Report NRS-76. Newtown Square, PA (2011).

nest predation and increase dispersal of invasive exotic plants and animals. In addition, the wellbore drilled through three caves in an important karst region.

Unexpected impacts included (1) extensive damage from drill pit fluids in three different locations; this damage included extensive short-term and long-term damage to the forest and soil caused by land application of fracking fluids at two locations, , and damage to two dozen trees immediately adjacent to the well pad likely due to loss of control of drill bore and aerial release of materials; (2) heavier-than-expected road damage during site development and drilling due to heavy equipment use, causing collapse of drainage ditches and significant road erosion; (3) last-minute changes in procedure for installing a pipeline across a tributary and wetland in a way likely to cause greater harm; and (4) equipment failures and truck accidents causing harm.

In sum, the EIS must thoroughly address the direct, indirect, and cumulative impacts of oil and gas development on NFGT species, including the above potential harms discussed in the West Virginia fracking wellsite study, Souther 2014, and Brittingham 2014 on RCW and other sensitive forest species. The agency must analyze the harms and dangers of fracking on RCW habitat and its effect on the species' recovery. This analysis should take into account the RCW's vulnerabilities to these impacts, such as their small population numbers and isolation, and sensitivity to fragmentation and "edge effects." The EIS should incorporate the most recent population data and best available science for RCW in the NFGT.

2. The EIS Must Analyze the Loss of Ecosystem Services from Fracking

A comprehensive study investigating the ecological impacts of recent oil and gas development across the central United States and Canada found that horizontal drilling and high-volume hydraulic fracturing have encouraged an average of 50,000 new wells per year since 2000, as well as large-scale vegetation loss, habitat fragmentation, and loss of ecosystem function and resilience. According to the study, unconventional oil and gas development is "transforming millions of hectares of the Great Plains into industrialized landscapes."[319] Vegetation removal by oil and gas development from 2000 to 2012 resulted in the loss of 10 teragrams (i.e., 10 million metric tons) of dry biomass, which reduces ecosystem resilience to drought and is "likely long-lasting and potentially permanent, as recovery or reclamation of previously drilled land has not kept pace with accelerated drilling."[320] The land area occupied by well pads, roads, and storage facilities built from 2000 to 2012 was ~3 million hectares. Oil and gas development increased fragmentation that can "sever migratory pathways, alter wildlife behavior and mortality, and increase susceptibility to ecologically disruptive invasive species."[321] The study also calculated that fracking removed between about 7 billion and 34 billion cubic meters of water from 2000 to 2012, and nearly half of wells drilled occurred in already highly or extremely water-stressed regions.

The EIS must consider the impact that opening up lands to oil and gas leasing will have on the forest's resilience to drought and climate change, as trees and other vegetation and water are removed from the ecosystem. The EIS must also consider the "long-lasting and potentially

[319] Allred, B.W. et al., Ecosystem services lost to oil and gas in North America. Science 348: 401-402 (2015).
[320] *Id.*
[321] *Id.*

permanent" impact of native vegetation removal, as reclamation activities will not necessarily restore the landscape to its former vegetation levels or bring back native vegetation. This could also have a long-term impact on the NFGT's habitat suitability and function.

3. The EIS Must Analyze Climate Change and its Effect on the Red-cockaded Woodpecker and other Species

The FS must consider climate change impacts on wildlife such as the RCW and its recovery, in connection with the impacts of new leasing and oil and gas development in RCW and other wildilfe habitat. Extreme weather is becoming more frequent and severe in the southeast due to the worsening climate crisis. FS must recognize and analyze the potential harms of extreme weather, and how increased fracking would compound these harms.

The climate crisis is intensifying the destructive power of hurricanes in three major ways by boosting their intensity, rainfall, and storm surge. As the temperature continues to warm hurricane intensity, rainfall, and storm surge will prove to be even more destructive. The EIS must analyze the destructive impact hurricanes can have on wildlife habitat. The Gulf Coast regularly experiences extreme weather. As weather patterns, e.g. hurricanes, rainfall, tornadoes, etc. are expected to intensify it is important for FS to discuss the impact extreme weather will have on the recovery of RCW and its habitat. A new report from the Center for Biological Diversity explains the factors that will contribute to more severe weather:

> "1. **Intensity:** Because hurricanes are fueled by heat, warming ocean temperatures are increasing the strength of hurricanes and allowing them to intensify more quickly. We are now experiencing the longest streak of Category 5 superstorms on record: Hurricane Dorian (2019) was the fifth Category 5 hurricane to form in the Atlantic in four years, following Michael (2018), Maria (2017), Irma (2017) and Matthew (2016). During 2017 and 2018 alone, five major hurricanes cost the United States at least 3,269 lost lives and $325 billion in damages.
>
> 2. **Rainfall:** Warmer air holds more moisture, causing heavier rainfall during hurricanes. In 2017 Hurricane Harvey dropped record amounts of rainfall, topping 60 inches over southeastern Texas, unleashing catastrophic flooding that left 89 dead, displaced more than 30,000 people, and damaged or destroyed more than 200,000 homes and businesses. Studies estimate that global warming made Harvey's downpour 3.5 times more likely and at least 19 percent more intense."

Powerful and destructive hurricanes have previously caused loss of RCW populations. In 1989 Hurricane Hugo a category 5, caused severe destruction of the RCW habitat and population in the southeast U.S. "After Hugo came through, an estimated 65 percent of the birds were dead or missing."[322] The storm destroyed 87 percent of the cavity trees and also damaged foraging habitat.[323]

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[322] Hoyle, Zoe, Red-cockaded Woodpeckers and Hurricanes, Compass Issue 12, Southern Research Station Headquarters, available at: https://www.srs.fs.usda.gov/compass/issue12/05redcockaded.html (Accessed last on Oct. 31, 2019).
[323] *Id.*

In 2005, Hurricane Katrina a category 5 hurricane hit the Gulf Coast and caused catastrophic damage. Some of the storm damage could be found in Big Branch Marsh National Wildlife Refuge near Lacombe, Louisiana where RCW populations are found. "Not only were some nests destroyed, but the woodpeckers' preferred habitat -- mature pine trees with open grassland below -- was decimated, with entire 100- to 200-acre sections lost."[324] Many of the surviving trees were attacked by ips beetles, leaving RCW populations homeless. "Non-native plants such as cogon grass, Japanese climbing fern and the ubiquitous Chinese tallow tree have opportunistically multiplied in the wake of Katrina's destruction and are adding to the strain on the woodpecker population by threatening to take over former pine savannas."[325] "Katrina killed or severely damaged 320 million large trees along the Gulf Coast -- enough to contribute to global warming as tons of dead biomass continue to decay."[326] After Hurricane Katrina, the Big Branch RCW population decreased from 17 families to 10. Much of the woodpecker habitat has been transformed into a hurricane created lake.[327] "Before-and-after aerial photographs of Big Branch show a striking conversion from swamp grass to open water, with about 2,400 acres of marsh lost in all."[328] This is another example of how powerful hurricanes are and the devastation they cause to wildlife and their habitat, including long-term conversion of wildlife habitat into areas no longer hospitable to native species.

G. The Forest Service Must Consider Increased Seismicity Risk and Other Geological Hazards from Fracking

The proliferation of unconventional oil and gas development, including increases in extraction and injection, will increase earthquake risk in the planning area. Accordingly, the EIS must fully assess the risk of induced seismicity caused by all unconventional oil and gas extraction and injection activities, including fracking and wastewater injection wells.

Research has shown that in regions of the central and eastern United States where unconventional oil and gas development has proliferated in recent years, atypical earthquake activity has been documented extensively.[329] There, earthquake count has increased dramatically over the last decade, with more than 300 earthquakes with magnitude (M) $\geq$ 3 between 2010 through 2012, or an average of 100 events/year, compared with an average of 21 per year between 1967 and 2000.[330] This surge of activity includes a magnitude 5.7 earthquake that struck Oklahoma in 2011, in close proximity to active fracking wastewater wells,[331] and a 5.8

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[324] Eggler, Bruce, Nature may take decades to recover from Katrina, NOLA.com, The Times-Picayune, Dec. 23, 2007, available at: https://www.nola.com/news/article_7920b476-ec77-5835-9113-9d92f4a52b34.html (Accessed last on November 27, 2019).

[325] *Id.*

[326] *Id.*

[327] *Id.*

[328] *Id.*

[329] Ellsworth,W.L. Injection-Induced Earthquack,341Science 1225942 (2013); Keranen, Katie et al., Potentially Induced Earthquakes in Oklahoma, USA: Links Between Wastewater Injection and the 2011 Mw5.7 Earthquake Sequence, Geology doi:10.1130/G34045.1 (March 26, 2013).

[330] Ellsworth 2013.

[331] Keranen, Katie M. et al., Potentially Induced Earthquakes in Oklahoma, USA: Links between Wastewater Injection and the 2011 Mw 5.7 Earthquake Sequence, 41 Geology 699 (2013).

magnitude quake on September 3, 2016 that proved to be the most powerful earthquake ever recorded in Oklahoma.[332]

Research has linked much of the increased earthquake activity and several of the largest earthquakes in the U.S. midcontinent in recent years to the disposal of wastewater into deep injection wells, which is well-established to pose a significant seismic risk.[333] With increasing water use for fracking operations, wastewater injection volumes will surely increase and increase the risk of earthquakes. The injected fluids push stable faults past their tipping points, and thereby induce earthquakes.[334]

Disposal of fracking wastewater in Class II wells has been associated with earthquakes in several US states, including Oklahoma, Colorado, New Mexico, Arkansas, and Ohio.[335] Horton (2012) attributed an earthquake swarm in northern Arkansas to fracking wastewater injection.[336] In the Raton Basin of southern Colorado and northern New Mexico, Rubinstein et al. (2014) presented evidence linking injection well disposal of produced water to seismic events.[337] Weingarten et al. (2015), in a study evaluating seismicity in multiple states, found a relationship between Class II wells and seismicity.[338]

In the panhandle regions of Oklahoma and Texas, all known earthquakes have occurred since petroleum development began between 1910 and 1920, suggesting induced seismicity.[339] The likelihood of this has only worsened as in the 21st century, there are oil and gas wells covering nearly the entire eastern Panhandle region of Texas. In this region and western Oklahoma, recent earthquake activity occurs where historical large earthquakes are absent. There are now earthquakes that coincide with high-rate wastewater disposal wells and hydraulic fracturing. Thus, the record indicates that some Panhandle earthquakes are natural in origin, but some are probably induced, especially in the eastern Panhandle.

Consistent evidence leads to the conclusion that disposal of wastewater from the production of oil and gas by deep injection is the probable cause of the surge of seismicity beginning in 2013 in Southern Kansas.[340] Seismicity correlates both in space and time with

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332 Chen, Xiaowei et al., The Pawnee earthquake as a result of the interplay among injection, faults and aftershocks, 7 Nature Scientific Reports 4945 (2017).
333 *Id.*
334 Lamont-Doherty Earth Observatory, Columbia University. Distant Quakes Trigger Tremors at U.S. Waste-Injection Sites, Says Study. July 11, 2013, available at: https://www.ldeo.columbia.edu/news-events/distant-quakes-trigger-tremors-us-waste-injection-sites-says-study.
335 EPA 2016 HF Study, p. 8-25.
336 Horton, S. (2012). Disposal of hydrofracking waste fluid by injection into subsurface aquifers triggers earthquake swarm in central Arkansas with potential for damaging earthquake. 83 Seismological Research Letters 250 (2012).
337 Rubinstein, JL et al., The 2001-present induced earthquake sequence in the Raton Basin of northern New Mexico and southern Colorado, 104 Seismological Society of America Bulletin 2162 (2014).
338 Weingarten, M et al., Induced seismicity. High-rate injection is associated with the increase in U.S. mid-continent seismicity. 348 Science 1336 (2015).
339 Walter, J. et al., Natural and Induced Seismicity in the Texas and Oklahoma Panhandles, Seismological Research Letters (2018).
340 Rubinstein, J. et al., The 2013-2016 Induced Earthquakes in Harper and Sumner Counties, Southern Kansas, 108 Bulletin of the Seismological Society of America 674 (2018).

injection. From 1974 to the time of injection increase in 2012, no magnitude 4 or larger earthquakes occurred in Harper and Sumner counties. However, 6 large earthquakes occurred between 2012 and 2016 after the increase in injection activity.

The mechanisms linking wastewater injection and earthquakes are understood: injection-induced increases in fluid pressure within aquifers and fault lubrication by injected fluids have the potential to destabilize well bores and cause preexisting faults to slip.[341] Injection-induced earthquakes pose a threat to public health both through the inherent destructiveness of earthquakes and the potential for earthquakes to jeopardize the integrity of oil and gas wells and create new pathways for fluid flow. New pathways for fluid flow could bring wastewater fluids or oil and gas into contact with the ground or surface water on which so many rely.

In addition, new studies have shown that fracking and not just wastewater injections can induce earthquakes. Induced seismicity has been linked to fracking events in Ohio, Oklahoma, and Canada.[342] A 2015 study showed that 77 earthquakes occurring in March 2014 near Youngstown, Ohio triggered a microfault previously unknown to operators and regulators, including a magnitude 3.0 earthquake.[343] Fracking has been inferred to trigger the majority of injection-induced earthquakes in western Canada.[344] And a recent 2019 study shows fracking is causing earthquakes in Texas.[345] Researchers warn that increased production in west Texas could lead to stronger and more damaging earthquakes.[346]

1. The EIS Must Take Into Account Local Geological Conditions in the Planning Area

Over the past several years, the rate of recorded seismicity in Texas has increased due to increased fracking activities, according to a report by the Academy of Medicine, Engineering

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[341] Brodsky, Emily and Lisa J. Lajoie, Anthropogenic Seismicity Rates and Operational Parameters at the Salton Sea Geothermal Field, 341 Science (2013); Davies, Richard et al., Induced Seismicity and Hydraulic Fracturing for the Recovery of Hydrocarbons, 45 Marine and Petroleum Geology 171 (2013).
[342] Arenschield, Laura, Study ties 77 Ohio earthquakes to two fracking wells, Columbus Dispatch (Jan. 8, 2015) ("Arenschield 2015"), available at http://www.dispatch.com/content/stories/local/2015/01/08/Research-ties-Ohio-quakes-to-fracking.html; Skoumal, Richard, et al., Earthquakes Induced by Hydraulic Fracturing in Poland Township, Ohio (2015), available at http://www.bssaonline.org/content/early/2015/01/01/0120140168.abstract; Soraghan, Mike, Okla. officials link some quakes to fracking, E&E News Energywire (Dec. 12, 2016), available at http://www.eenews.net/energywire/stories/1060047006/; Gronewold, Nathaniel, New research suggests fracking triggered active faults, E&E News Energywire (November 28, 2016), available at http://www.eenews.net/energywire/stories/1060046240/; Mahani, Alireza B. et al., Fluid Injection and Seismic Activity in the Northern Montney Play, British Columbia, Canada, with Special Reference to the 17 August 2015 Mw 4.6 Induced Earthquake, 107 Bulletin of the Seismological Soc'y of Am. 542 (2017).
[343] Arenschield 2015.
[344] Bao, X. and Eaton, D.W., Fault activation by hydraulic fracturing in western Canada, Science 10.1125/science.aag2583 (2016).
[345] Kuchment, Anna, Fracking may indeed be causing earthquakes in Texas, according to UT study, Dallas Morning News (Nov. 11, 2019), https://www.dallasnews.com/news/environment/2019/11/11/fracking-may-indeed-be-causing-earthquakes-in-texas-according-to-ut-study/
[346] *Id.*

and Science of Texas on the impacts of shale development in Texas.[347] While between 1975 and 2008 there were roughly one to two earthquakes per year of a magnitude greater than M3.0, between 2008 and 2016, the rate increased to about 12 to 15 earthquakes per year.[348] The majority of known faults in the subsurface of Texas are stable and not prone to generating earthquakes, but under particular geologic conditions, faults at or near critical stress may slip and generate an earthquake if nearby fluid injection alters the effective subsurface stresses acting on the fault.[349] Of the 162 total Texas earthquakes recorded (as of 2017), 94 have occurred since 2008.[350] The report concludes that this seismicity increase is significant because a common instrumental threshold to magnitude M3.0 on the Richter scale extends back to 1975.[351] Based on the extent of research performed to date, the report found consensus among experts that significant spatial and temporal seismicity increases in the Central United States are "associated with disposal of wastewater from shale development activities in proximity to existing faults at or near critical stress conditions."[352]

In Texas, seismic activity has occurred far away from sites of wastewater injection. In the Fort Worth Basin, for example, scientists found cumulative pressure increase from wastewater injection triggered swarms of earthquakes on faults located tens of kilometers or more from injection wells.[353] There, the cumulative number of earthquakes having magnitudes of 3 or more increased roughly exponentially, since 2008.[354] The study concluded that the spread of earthquakes was likely caused by the migration of fluids introduced into the subsurface by wastewater-injection operations.[355] These fluids migrated and continued to build up pressure after the wastewater-injection operations had ceased. Wastewater-injection ceased in approximately July-October of 2012, but the earthquakes continued until mid-2015. Some of the earthquakes occurred more than 10 miles from the wastewater-injection operations.[356] The study suggests small earthquakes may also be precursors to large earthquakes or swarms, as fluid pressure increases with increased wastewater injection.[357] Another recent study suggests far-field pressurization from clustered, high-rate wells greater than 12 km from an earthquake sequence in Fairview, Oklahoma (of five earthquakes with Mw 4.4 or larger) induced these earthquakes, and points to the far-reaching impact of wastewater injection.[358]

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[347] The Academy of Medicine, Engineering and Science of Texas, Environmental and Community Impacts of Shale Development in Texas, 44 (2017) ("Texas Shale Report"), *available at:* http://tamest.org/wp-content/uploads/2017/07/Final-Shale-Task-Force-Report.pdf.
[348] *Id.*
[349] *Id.* at 67, 44.
[350] *Id.* at 54.
[351] *Id.*
[352] *Id.* (citing Ellsworth, William L., Injection-Induced Earthquakes 341 Science 142 (2013)).
[353] Hornbach, M.J., et al., Ellenburger wastewater injection and seismicity in North Texas, Physics of the Earth and Planetary Interiors (2016), doi: http://dx.doi.org/10.1016/j.pepi.2016.06.012 ("Hornbach 2016").
[354] *Id.* (cumulative pressure increase across the basin may trigger earthquakes on faults located tens of kilometers or more from injection wells, and this process may have triggered the Irving-Dallas earthquake sequence).
[355] *Id.*
[356] *Id.*
[357] *See also* Oklahoma Geological Survey, Oklahoma Earthquakes FAQs, available at http://www.ou.edu/content/ogs/research/earthquakes/oklahoma-earthquakes-faqs.html (explaining that stronger earthquakes become likely with more frequent earthquake activity).
[358] Yeck, W. L., M. Weingarten, H. M. Benz, D. E. McNamara, E. A. Bergman, R. B. Herrmann, J. L. Rubinstein, and P. S. Earle (2016), Far-field pressurization likely caused one of the largest injection induced earthquakes by

Accordingly, new oil and gas development, and increased wastewater injection associated with new development, may cumulatively increase the risk of increased earthquake activity, and larger quakes occurring significant distances from injection sites. The EIS must analyze local subsurface conditions in the NFGT and their susceptibility to earthquake risks from fracking and wastewater injection.

2. The EIS Must Analyze the Impacts of Earthquakes on Sensitive Infrastructure

The EIS must also analyze the potential for increased manmade earthquake risks near reservoirs within the planning area, including Toledo Bend Lake, Lake Conroe, and Sam Rayburn Reservoir. The Forest Service must disclose in the EIS the history of earthquake activity at each reservoir; analyze recent earthquakes in this area and their probable cause; and analyze to what extent increased oil and gas activity here may worsen seismic risks and impact the safety of each reservoir's dam. It must also disclose any risks to water contamination and downstream communities, which could result from increased seismic activity.

In 2013, a *Dallas Morning News* interview noted that Army Corps experts "have envisioned a scenario in which naturally occurring faults might transfer the high-pressure force of fracking upward towards a dam's foundation," weakening the foundation, and that fracking "tops the corps' list of worries."[359] The same Army Corps expert has noted a host of other risks associated with fracking beneath dams, including:

> Transmission of fracking fluids outside target zone via natural faults
> • Erosion of embankment in contact with faults could trigger failure
>
> Disposal of flowback water
> • Potential for contamination of ground and surface water
>
> Wells can be fractured multiple times, so project risk associated with frac'ing can occur over the life of the well …
>
> Poorly controlled hydrofracturing ("breakouts")
> • Erosion of the embankment along existing faults located in the foundation, abutments or outlet works could lead to project failure*
> *Failure defined as an uncontrolled loss of pool or flood storage
>
> Induced Seismicity
> • Consolidation of granular drains
> • Liquefaction
> • Stability

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reactivating a large preexisting basement fault structure, 43 Geophys. Res. Lett., 10,198–10,207, doi:10.1002/2016GL070861.

[359] Loftis, Randy Lee, Corps worries that fracking gas wells might hurt dams, Dallas Morning News ("Loftis 2011") (July 31, 2011) available at http://www.dallasnews.com/news/community-news/grand-prairie/headlines/20110731-corps-worries-that-fracking-gas-wells-might-hurt-dams.ece.

• Cracking
• Displacement[360]

According to the Army Corps expert, these concerns must be addressed because when dams were constructed, mitigation for fracking impacts were "not incorporated into project design."[361] Indeed, dams in Texas were not built to withstand seismic events, since historically earthquakes were not common occurrences until the fracking boom.[362] These structures could therefore be increasingly at risk as seismic events increase.

Earthquakes have caused structural damage to dams, which are sensitive to any movement of basement faults. In 1963, oil-and-gas-operations-induced subsidence of the ground underlying the Baldwin Hills Reservoir in southwest Los Angeles was a potential cause of the dam's breach that resulted in the release of 250 million gallons of water into the housing subdivisions below the dam.[363] The breach destroyed or damaged 277 homes and killed five people.[364] Movement of geologic faults crossing the floor of the reservoir caused a crack in the asphalt bottom of the reservoir and allowed water to enter the porous soil beneath the dam. The movement of the faults was possibly caused by "either 1) natural causes inherent in the geologic setting; 2) subsidence of the ground surface caused by oil and gas operations or by the filling of the reservoir with water; or 3) pressure injection of water in the [neighboring] Inglewood Field at shallow depths for oil and gas operations and in the presence of a fault system."[365]

In light of these risks, a recent study that outlines a framework for risk assessment to analyze potential harm to sensitive infrastructure from induced seismicity in Canada, recommends an "exclusion zone within a 5 km radius (in horizontal space) surrounding vulnerable high-consequence facilities… and monitoring and response protocol to ensure that activity rates beyond the exclusion zone, to approximately 25 km, are kept below a specified limit."[366] The study stresses that these recommendations are meant to address induced seismicity from the hydraulic fracturing process, and that wastewater disposal wells may require a larger exclusion zone of 10 km.[367] The Forest Service should consider the potential for manmade earthquakes to impact sensitive infrastructure such as pipelines, bridges, and dams in and around the planning area. The Forest Service should also adopt these recommended exclusion zones for all lakes and dams in the planning area in the form of stipulations to be attached to oil and gas

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[360] Branch, Anita, U.S. Army Corps of Engineers, Potential Impacts of Hydrafracturing on Dam & Levee Safety Power Point Presentation, 11-12 (2013), available at https://www.astm.org/COMMIT/images/6C_Branch_2013-01-29_ASTM.pdf.
[361] *Id*. at 16,
[362] Hill, David, Engineers Work to Ensure Dam Safety as Earthquakes Increase, Civil Engineering, 38 (Dec 2015).
[363] National Research Council, Induced Seismicity Potential in Energy Technologies, The National Academies Press (2012) at 197, available at http://home.ustc.edu.cn/~ly2014/Advances_in_Geosciences/_document/Induced%20Seismicity%20Potential%20in%20ENERGY%20TECHNOLOGIES.pdf.
[364] *Id*.
[365] *Id*. at 198.
[366] Atkinson, Gail, Strategies to prevent damage to critical infrastructure due to induced seismicity. Department of Earth Sciences, Western University, Canada (2017) ("Atkinson 2017"), available at http://www.inducedseismicity.ca/wp-content/uploads/Atkinson2017-FACETS.pdf.
[367] *Id*.

leases. These exclusion zones should limit both fracking activities and wastewater disposal/injection activities near dams and lakes.

The Forest Service must make sure the EIS thoroughly assesses geological hazards and increased seismicity risks at the planning stage, for individual regions where increased federal oil and gas development is reasonably expected, including the Barnett and Haynesville shale plays.

H. Conclusion

Oil and gas development not only fuels the climate crisis but entails significant public health risks and harms to the environment. Accordingly, the Forest Service should end new federal fossil fuel leasing on the NFGT. At a minimum, the Forest Service must prepare an EIS that thoroughly analyzes the effects of fossil fuel extraction in the planning area, as compared to the alternatives of (1) no new fossil fuel leasing; (2) no fracking or other unconventional well stimulation methods within the planning area; (3) no fracking or other oil and gas extraction beneath and around dams and lakes, as recommended by the best available science; and/or (4) significantly limits on oil and gas leasing and/or fossil fuel extraction throughout the planning area, in consideration of their impacts on climate change, water resources, air quality, seismicity, and wildlife. Thank you for your consideration of these comments, and please feel free to contact us if you have any questions about our comments or the references we have submitted.

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