U.S. Department of the Interior
Bureau of Land Management

Willow Master Development Plan

Environmental Impact Statement

DRAFT

Volume 1: Executive Summary, Chapters 1-5, Glossary, and References
August 2019

Prepared by:
U.S. Department of the Interior
Bureau of Land Management

In Cooperation with:
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Coast Guard
U.S. Department of Transportation
Native Village of Nuiqsut
Iñupiat Community of the Arctic Slope
City of Nuiqsut
North Slope Borough
State of Alaska

Estimated Total Costs Associated with
Developing and Producing this EIS:
$5,281,000

Mission

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

Cover Photo Illustration: Caribou in the Alpine Development on Alaska's North Slope.
Photo by: Wendy Mahan, courtesy of ConocoPhillips.

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Draft Environmental Impact Statement

Volume 1: Executive Summary, Chapters 1 through 5, Glossary, and References

Prepared by:
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Anchorage, Alaska

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North Slope Borough
State of Alaska

August 2019

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DRAFT ENVIRONMENTAL IMPACT STATEMENT WILLOW MASTER DEVELOPMENT PLAN PROJECT

Lead Agency:	U.S. Department of the Interior, Bureau of Land Management (BLM)
Cooperating Agencies:	U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Coast Guard, U.S. Department of Transportation, Pipeline and Hazardous Material Administration, State of Alaska, North Slope Borough, Native Village of Nuiqsut, City of Nuiqsut, and the Iñupiat Community of the Arctic Slope.
Proposed Action:	Construct the infrastructure necessary to allow the production and transportation to market of federal oil resources under leaseholds in the northeast area of the National Petroleum Reserve in Alaska (NPR-A), consistent with the Proponent's (ConocoPhillips Alaska, Inc.) federal oil and gas lease and unit obligations.

Abstract: The Willow Master Development Plan (MDP) Draft Environmental Impact Statement (EIS) contains one No Action Alternative (Alternative A) and three action alternatives (Alternatives B, C, and D) for a new development proposed by ConocoPhillips Alaska, Inc. on federal oil and gas leases in the northeast area of the NPR-A. If the EIS is approved, the Proponent may submit applications to build up to five drill sites, a central processing facility, an operations center pad, gravel roads, ice roads and ice pads, 1 or 2 airstrips (varies by alternative), a module transfer island, pipelines, and a gravel mine site. The Willow MDP Project would have a peak production of 130,000 barrels of oil per day over its 30- or 32-year life (varies by alternative), producing approximately 590 million total barrels of oil, and would help offset declines in production from the North Slope oil fields and contribute to the local, state, and national economies. The EIS describes proposed infrastructure and potential effects on the natural, built, and social environments. The action alternative discussion includes existing lease stipulations and best management practices and proposed mitigation measures to avoid, reduce, and minimize the potential effects. The BLM and other state and federal agencies will decide whether to authorize the Willow MDP Project, in whole or in part, based on the analysis contained in this Draft EIS, as well as other state and federal permit review processes.

The Draft EIS analyzes the following resources in detail: climate and climate change; air quality; soils, permafrost, and gravel resources; contaminated sites; noise; visual resources; water resources; wetlands and vegetation; fish; birds; terrestrial mammals; marine mammals; land ownership and use; economics; subsistence and sociocultural systems; environmental justice; and public health.

Review Period:	The review period on the Willow MDP Draft EIS is 45 calendar days. The review period began when the BLM published a notice of availability in the *Federal Register* on August 30, 2019. The comment period ends on October 15, 2019.
Further Information:	Contact Ms. Racheal Jones, BLM Alaska Project Manager, at 907-290-0307 or visit the Willow MDP EIS website at https://www.blm.gov/programs/planning-and-nepa/plans-development/alaska/willow-eis.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Alaska State Office
222 West Seventh Avenue, #13
Anchorage, Alaska 99513-7504
http://www.blm.gov/ak

August 2019

Dear Reader:

Enclosed is the Willow Master Development Plan (MDP) Draft Environmental Impact Statement (EIS) for your review. The Bureau of Land Management (BLM) prepared this Draft EIS in consultation with federal, tribal, state, and local cooperating agencies in accordance with the National Environmental Policy Act of 1969, as amended, and the Federal Land Policy and Management Act of 1976, as amended; implementing regulations; and other applicable law and policy. The Draft EIS provides the BLM's analysis of the project and disclosure of potential impacts.

The Willow MPD is a new development proposed by ConocoPhillips Alaska, Inc. (the Proponent). The Proponent's proposed project is to construct drill sites, roads, pipelines, and ancillary facilities to support production and transportation to market of oil and gas resources under leaseholds in the National Petroleum Reserve in Alaska (NPR-A). The NPR-A is within the North Slope Borough (NSB) and is predominantly managed by the BLM. The BLM is responsible for land-use approvals and compliance with the NPR-A Integrated Activity Plan. The decision to be made from this EIS process is whether BLM will authorize the Project, in whole or in part, based on the analysis contained in this Draft EIS, as well as other state and federal permit review processes.

The BLM encourages the public to review and provide comments on the Draft EIS. The BLM is particularly seeking constructive feedback regarding the adequacy of the alternatives considered and the analysis of direct, indirect and cumulative impacts. The BLM is interested in any new information that would help the agency produce the Final EIS, which will aid decision makers in selecting an alternative and providing stipulations related to the proposal.

Comments will be accepted for 45 calendar days following publication of the U.S. Environmental Protection Agency's Notice of Availability in the *Federal Register*. Please submit comments and any resource information within the review period.

The Draft EIS is available for review online on the project website at www.blm.gov/alaska/WillowEIS. Paper copies are also available for public review as the following locations:

> BLM Alaska State Office, Public Information Center (Public Room)
> 222 West 7th Avenue
> Anchorage, Alaska 99513
>
> BLM Fairbanks District Office
> 222 University Avenue
> Fairbanks, Alaska 99709

Comments may be submitted electronically, by mail or in person. To facilitate analysis of comments and information submitted, the BLM encourages you to submit comments in an electronic format.

Electronically: www.blm.gov/alaska/WillowEIS

Email: BLM_AK_Willow_Comments@blm.gov

Mail or Hand-deliver: Willow EIS Comments, BLM Public Room, 222 West 7th Avenue, Anchorage, Alaska 99513

Your review and comments are critical to the success of BLM decision making. We request that you make your comments as specific as possible. Comments are most helpful if they include suggested changes, data sources, or analysis methods and refer to a section or page number. Comments containing only opinion or preference will be considered as part of the decision-making process but will not receive a formal response from the BLM.

Before including your address, phone number, email address, or other personal identifying information in your comment, be advised that your entire comment - including your identifying information - may be made publicly available at any time. While you may ask us in your comments to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Public meetings and hearings will be held at various locations in the project area and in Fairbanks and Anchorage, with opportunities to submit comments and seek additional information. The locations, dates and times of these meetings will be announced at least fifteen (15) calendar days prior to the first meeting via a press release and on the project website.

Thank you for your interest in the Willow Draft EIS. We appreciate the information and suggestions you contribute to this EIS process.

Sincerely,

Ted A. Murphy
Associate State Director, Alaska

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ACRONYMS

°F	degrees Fahrenheit
μPa	micropascal, a unit of pressure
2:1	2 horizontal to 1 vertical ratio
AAAQS	Alaska Ambient Air Quality Standards
ACP	Arctic Coastal Plain
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
APDES	Alaska Pollutant Discharge Elimination System
AQRV	air quality related value
AQTSD	Air Quality Technical Support Document
AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
ASRC	Arctic Slope Regional Corporation
AST	aboveground storage tank
ASTAR	Arctic Strategic Transportation and Resources project
ATV	all-terrain vehicle
BLM	Bureau of Land Management
BMP	best management practice
BOEM	Bureau of Ocean and Energy Management
BT1	Bear Tooth drill site 1
BT2	Bear Tooth drill site 2
BT3	Bear Tooth drill site 3
BT4	Bear Tooth drill site 4
BT5	Bear Tooth drill site 5
BTU	Bear Tooth Unit
CAH	Central Arctic Herd
CAMx	Comprehensive Air Quality Model with Extensions
CAPS	criteria air pollutants
cfs	cubic feet per second
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPAI	ConocoPhillips Alaska, Inc.
CPF	central processing facility
CRD	Colville River Delta
CWA	Clean Water Act
cy	cubic yards
dB	decibels
dBA	A-weighted decibel used to characterize airborne noise, referenced to 20 μPa
DEIS	Draft Environmental Impact Statement
DEW	Distant Early Warning
dv	deciviews
EED	Environmental Evaluation Document
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency

ESA	Endangered Species Act
FECP	Facility Erosion Control Plan
FLIR	forward-looking-infrared
FLM	Federal Land Managers
GHG Model	Greenhouse Gas Lifecycle Model
GHG	greenhouse gas
GMT	Greater Mooses Tooth
GMT-1	Greater Mooses Tooth 1
GMT-2	Greater Mooses Tooth 2
GPS	global positioning system
GWP	global warming potential
HAP	hazardous air pollutant
HDD	horizontal directional drilling
HEC	health effects category
HSM	horizontal support member
HUC	Hydrologic Unit Code
IAP	Integrated Activity Plan
IPCC	Intergovernmental Panel on Climate Change
kg N/ha/year	kilograms nitrogen per hectare per year
kg/ha/year	kilogram per hectare per year
km	kilometers
KOP	key observation point
Kuparuk	Kuparuk River Unit
Kuukpik	Kuukpik Corporation
LS	lease stipulation
m	meters
MDP	Master Development Plan
MG	million gallons
mg/L	milligrams per liter
MMT	million metric tons
Mt	thousand metric tons
MTI	module transfer island
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEI	Northern Economics Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_3^-	nitrate
NOx	nitrogen oxides
NPR-A	National Petroleum Reserve in Alaska
NPRPA	Naval Petroleum Reserves Production Act
NPS	National Park Service
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NSSRT	North Slope Spill Response Team
NTU	nephelometric turbidity unit
NVN	Native Village of Nuiqsut
NWI	National Wetland Inventory
O_3	ozone
ODPCP	Oil Discharge, Pollution, and Contingency Plan
OHW	ordinary high water

Pb	Lead
PM_{10}	particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
Project	Willow Master Development Plan Project
Proponent	ConcocoPhillips Alaska, Inc.
PSD	Prevention of Significant Deterioration
Q1	first quarter
Q4	fourth quarter
RCRA	Resource Conservation and Recovery Act
REL	reference exposure level
RfC	reference concentration
RFFAs	reasonably foreseeable future actions
RMS	Regional Mitigation Strategy
rms	root mean square
ROD	Record of Decision
Secretary	Secretary of the Interior
SO_2	sulfur dioxide
SO_4^{2-}	sulfate
SPCC	Spill Prevention Control and Countermeasures
SRA	Spill Risk Assessment
SS	suspended solids
State	State of Alaska
SWPPP	Stormwater Pollution Prevention Plan
TAPS	Trans-Alaska Pipeline System
TCH	Teshekpuk Caribou Herd
TLSA	Teshekpuk Lake Special Area
TSS	total suspended solids
U.S. Census	U.S. Census Bureau
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds
VRI	Visual Resource Inventory
VRM	Visual Resource Management
VSMs	vertical support members
Willow area	area around the gravel infrastructure and mine site for the Project
WOC	Willow Operations Center
WOUS	Waters of the United States
WPF	Willow processing facility
WSE	water surface elevation

EXECUTIVE SUMMARY

1.0 INTRODUCTION

The Bureau of Land Management (BLM) received a request from ConocoPhillips Alaska, Inc. (the Proponent) on May 10, 2018, to prepare the Willow Master Development Plan (MDP) Environmental Impact Statement (EIS). The Proponent is proposing the MDP to construct infrastructure components for drill sites, roads, pipelines, and ancillary facilities to support the safe and economic production and transportation to market of oil and gas resources under leaseholds in the National Petroleum Reserve in Alaska (NPR-A) (Figure ES.1). Once the Final EIS and Record of Decision (ROD) are approved, the Proponent may submit permit applications for up to five drill sites, a central processing facility, an operations center pad, up to 38.2 miles of gravel roads, up to 698.8 total miles of ice roads during construction and up to 215.6 total miles of resupply ice roads during operations, one to two airstrips, up to 336.5 miles of pipelines (on 94.3 miles of new piperack), and a gravel mine site on federal land in the NPR-A. In addition, the Proponent would submit applications to the State of Alaska for a module transfer island (MTI) on State of Alaska submerged lands. Actions on both state and federal lands are considered in the EIS. The Willow MDP Project (Project) is anticipated to have a peak production of 130,000 barrels of oil per day over its 30-year life (producing approximately 590 million barrels of oil) and would help offset declines in production from the North Slope oil fields and contribute to the local, state, and national economies.

The Naval Petroleum Reserves Production Act, as amended (NPRPA), requires the Secretary of the Interior to conduct oil and gas leasing in the NPR-A. Congress authorized petroleum production in the NPR-A in 1980 (PL 96-514), but it was not until the 1990s that development on adjacent state lands made exploration in the NPR-A economically feasible. In 1998, the Bureau of Land Management (BLM) completed an Integrated Activity Plan (IAP) that assessed the potential use of the Northeast NPR-A for oil development (BLM 1998). The 1998 IAP was amended in 2005 and supplemented in 2008 (BLM 2005, 2008c). In 2012, the BLM completed an IAP/EIS that analyzed development scenarios and related environmental consequences for all BLM-managed federal lands and oil and gas resources within the NPR-A (BLM 2012b). The IAP/EIS ROD was issued in 2013 (BLM 2013a). The Willow MDP EIS tiers to the 2012 IAP/EIS and the 2013 ROD.

2.0 PURPOSE AND NEED

The purpose of the Proposed Action is to construct the infrastructure necessary to allow the production and transportation to market of federal oil and gas resources under leaseholds in the northeast area of the NPR-A, consistent with the Proponent's federal oil and gas lease and unit obligations. The need for federal action (i.e., issuance of authorizations) is established by the BLM's responsibilities under various federal statutes, including the NPRPA (as amended), Mineral Leasing Act, and Federal Land Policy and Management Act, as well as various federal responsibilities of cooperating agencies under other statutes, including the Clean Water Act. Under NPRPA, the BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC Section 6506a). The BLM is required to respond to the Proponent's requests for an MDP and related authorizations to develop and produce petroleum in the NPR-A.

The U.S. Army Corps of Engineers (USACE), as a cooperating agency on this EIS, develops their own overall purpose for the project in accordance with their Section 404 Clean Water Act regulations. The overall purpose of the Project, as defined by the USACE, is to construct infrastructure to safely produce, process, and transport commercial quantities of liquid hydrocarbons to market via pipeline from the Willow reservoir. The overall Project purpose and need allows a robust consideration of alternatives while providing a foundation to determine practicability, which is a key aspect of the USACE's Section 404 permitting process. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall Project purposes (40 CFR 230.10(a)(2)).

The purpose and need of the Proposed Action is a key factor in determining a range of alternatives required for consideration in an EIS and assists with the selection of a preferred alternative. The Draft EIS (DEIS) presents a reasonable range of alternatives that consists of a No Action Alternative and three action alternatives. The DEIS analyzes the environmental impacts of these alternatives and informs how well each alternative meets the project purpose and need.

3.0 DECISION TO BE MADE

The BLM is the federal land manager of the NPR-A, responsible for land use authorizations and compliance with the requirements of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.). The BLM and other authorizing cooperating agencies will decide whether to authorize the Proposed Action, in whole or in part, based on the analysis contained in this EIS, as well as other state and federal permit review processes. The ROD(s) associated with this EIS will not constitute the final approval for all actions, such as approval for subsequent individual applications for permits to drill and rights-of-way associated with the Proposed Action. The EIS analysis does, however, provide the BLM and other agencies that have regulatory oversight and permitting authorities with information and NEPA analysis that could be used to inform final approvals for individual project components, such as permits to drill and rights-of-way.

4.0 PROJECT AREA

The Willow MDP area (Project area or Willow area) is located on the North Slope of Alaska, with the majority of the proposed facilities on leased federal lands within the northeastern portion of the NPR-A (Figure ES.2). Supporting infrastructure, including road connections, pipeline tie-ins, the MTI, and the gravel mine site would be located on lands owned by various entities in the Greater Mooses Tooth (GMT) Unit, on un-unitized lands within the NPR-A, on private lands owned by Kuukpik Corporation (Kuukpik), and on lands or waters owned and managed by the State of Alaska. None of the facilities would be located on or near Native allotments. The pipelines would be colocated with existing pipelines on private land.

Elements of the Project would occur within the Teshekpuk Lake Special Area of the NPR-A, which was designated by the Secretary of the Interior in 1977 for its significant value to waterfowl and shorebirds. The designation has since been expanded to protect caribou, waterbirds, shorebirds, and their habitats.

5.0 SCOPING AND ISSUES

As part of the Project scoping process, the BLM considered public and agency comments received during scoping meetings and in consultation with Alaska Native Tribes. The original scoping period was 30 days; however, it was extended by 14 days due to public requests and officially ended on September 20, 2018. The community of Nuiqsut was given an additional 8 days to comment, for a total of 52 days. Public scoping meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik. The scoping summary report is provided in Appendix B, *Scoping Summary Report*.

Issues identified during scoping included potential impacts to caribou and other wildlife species, wildlife migration patterns and habitat fragmentation, special areas protected under the IAP (BLM 2012b), subsistence use and traditional ways of life, stakeholder engagement, alternatives development, and the long-term effects of climate change. These and other issues raised are addressed in the EIS.

6.0 ALTERNATIVES

The range of alternatives developed for detailed analysis in the EIS consists of the No Action Alternative (Alternative A) and three action alternatives (Alternatives B, C, and D) (Figures ES.2 and ES.3); additionally, two sealift module delivery options (Options 1 and 2) are included (Figure ES.2) All action alternatives and options were evaluated for their ability to meet the Project purpose and need and other screening criteria. Chapter 2.0, *Alternatives*, of the EIS describes the action alternatives, module delivery options, and Project features common to all action alternatives. A detailed description of the alternatives development process, screening criteria, and alternative elements considered but eliminated from further analysis, as well as each alternative and option, is included in Appendix D, *Alternatives Development*.

Activity in the NPR-A is subject to a variety of lease stipulations (LSs) and best management practices (BMPs) intended to reduce effects from development activity; these LSs and BMPs are detailed in the 2013 NPR-A IAP/EIS ROD (BLM 2013a). Many of the previously identified LSs and BMPs are readily incorporable into the Project alternatives, though some LSs and BMPs may require exceptions or deviations due to Project constraints and would be evaluated by the BLM on a case-by-case basis. Table 2.6.1 of this EIS lists applicable LSs and BMPs from the 2013 NPR-A IAP/EIS ROD (BLM 2013a) anticipated to be applicable to the Project.

6.1 Alternative A: No Action Alternative

Under Alternative A, the Project would not be constructed; however, oil and gas exploration in the area would continue. Under the NPRPA, BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). Alternative A would not meet the Project's purpose and need but is included for detailed analysis to provide a baseline for the comparison of impacts of the action alternatives (BLM 2008, Section 6.6.2, No Action Alternative; 40 CFR 1502.14(d)).

6.2 Alternative B: Proponent's Project

Alternative B would include 38.2-miles of gravel road and seven bridges connecting five Project drill sites to the Greater Mooses Tooth 2 (GMT-2) development. Infield (multiphase) pipelines would connect individual drill sites to the Willow processing facility (WPF) and export/import pipelines would connect the WPF to existing infrastructure on the North Slope. Diesel would be trucked by road to the Project area from the Alpine development. A single airstrip would be located at the Willow Operations Center (WOC). There would be a total gravel footprint of 442.7 acres. Sealift module delivery to the Project area from an MTI located at Atigaru Point or Point Lonely would be required.

The alternative was developed to by the Proponent to provide a gravel access road from the existing gravel road network in the GMT and Alpine developments to the Project facilities. Alternative B is BLM's preferred alternative.

6.3 Alternative C: Disconnected Infield Roads

Alternative C would include the same gravel access road between the GMT-2 development and the Project area as Alternative B, but it would not have a gravel road connection from the WPF to Bear Tooth drill site 1 (BT1). A gravel infield road would connect BT1 with Bear Tooth drill site 4 (BT4) using the same alignment as Alternative B, for a total of 36.8 miles of gravel roads with six bridges. An annual 3.9-mile ice road would be constructed along the Alternative B infield road alignment from the WPF to BT1. A second airstrip, storage and staging facilities, and camp would be located near Bear Tooth drill site 2 (BT2). The WPF, South WOC, and primary Project airstrip would be located approximately 5 miles east of their location in Alternative B, near the eastern Bear Tooth Unit boundary. A diesel pipeline would provide fuel from Kuparuk CPF2 to the North and South WOCs. Alternative C would have a total gravel footprint of 487.8 acres. Sealift module delivery to the Project area from an MTI located at Atigaru Point or Point Lonely would be required.

The intent of Alternative C is to reduce effects to caribou movement and decrease the number of stream crossings required; this is also intended to further reduce impacts to subsistence users of these resources, and reduce impacts to hydrology and wetlands.

6.4 Alternative D: Disconnected Access

Alternative D would not have gravel road access connection from GMT-2 but would employ the same gravel infield roads (with six bridges) as Alternative B, for a total of 28.3 miles of gravel roads. Annual resupply access to the Project area would be provided by ice road between GMT-2 and the WPF (9.8 miles). Alternative D would colocate the WPF with Bear Tooth drill site 3 (BT3) (like Alternative B) and have five total drill sites and a single airstrip. A diesel pipeline would provide fuel from Kuparuk CPF2 to the WOC (similar to Alternative C). There would be a total gravel footprint of 410.7 acres. Sealift module delivery to the Project area from an MTI located at Atigaru Point or Point Lonely would be required.

The intent of Alternative D is to minimize the Project's footprint and fill, reduce the number of required bridges, and lessen the length of linear infrastructure on the landscape to decrease effects to caribou movement and subsistence. The alternative would also reduce impacts to hydrology and wetlands.

6.5 Sealift Module Delivery Options

A total of six sealift barges are anticipated for the Project to deliver large, prefabricated modules to the North Slope. Two module delivery options are analyzed (Figure ES.2): Option 1 and Option 2. Both options would construct a gravel island (i.e., an MTI) with a 5- to 10-year design life. Either option could be coupled with any of the three action alternatives. Appendix D includes additional details for each option.

6.5.1 Option 1: Proponent's Module Transfer Island

The Proponent proposes construction of an MTI approximately 2.4 miles offshore in Harrison Bay near Atigaru Point to support sealift module delivery. The MTI would be constructed from gravel sourced from the Tiŋmiaqsiuġvik Mine Site and would provide an approximately 8.3-acre gravel work surface with a 12.8-acre overall gravel footprint. MTI slopes would be armored with gravel bags and a 200-foot-long sheet pile dock face would facilitate barge offloading. Modules would be barged to the MTI in the summer and stored until the following winter when they would be transported to the Project area via ice road. A total of 117.1 miles of ice road would be needed. The summer following the final sealift module delivery, the island would be abandoned, and all facilities and anthropogenic materials would be removed, including the gravel slope protection. It is anticipated the top of the island would drop below the water surface in 10 to 20 years following abandonment as it is reshaped by ice and waves. The option was developed to provide the shortest delivery route without requiring dredging or additional marine impacts. Option 1 is BLM's preferred module delivery option.

6.5.2 Option 2: Point Lonely Module Transfer Island

This option would locate a similarly constructed and sized MTI (13.0-acre gravel footprint) approximately 0.6 mile offshore at Point Lonely, a former Department of Defense site. A total of 229.7 miles of ice road would be needed to support MTI construction and module transport to the Project area. The intent of this option is to move the MTI away from Nuiqsut's high subsistence use area, and to utilize existing onshore gravel infrastructure at Point Lonely for staging purposes.

7.0 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Chapter 3.0, *Affected Environment and Environmental Consequences,* of the EIS details the affected environment for social, physical, and biological resources and the potential environmental impacts associated with each of the alternatives and options. Potential impacts for each resource are described in terms of type, context, duration, and intensity.

Table ES.1 summarizes and compares key potential environmental impacts on resources and uses for each action alternative. Table ES.2 provides a summary comparison of key impacts for sealift module delivery options. For more information on all potential impacts, please refer to Chapter 3.0 of the EIS.

Table ES.1. Summary Comparison of Key Impacts by Action Alternative

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Total gravel footprint and gravel fill volume	Soil disturbance and permafrost thaw Loss of gravel resources Changes to undisturbed characteristic visual landscape including night skies Wetlands lost Habitat loss for fish, birds, caribou, and polar bears Disturbance and displacement of birds, caribou, and polar bears Subsistence hunter avoidance	442.7 acres using 4.7 million cubic yards of gravel 429.9 acres of wetlands and WOUS fill 9,775.3 acres of disturbance for birds[a] (5,171.3 in high-use areas) Lesser potential for subsistence hunter avoidance due to infrastructure footprint. Lesser direct loss of subsistence use areas due to reduction in overall infrastructure footprint.	487.8 acres using 5.4 million cubic yards of gravel 478.6 acres of wetlands and WOUS fill 10,214.2 acres of disturbance for birds[a] (5,209.9 in high-use areas) Greatest potential for subsistence hunter avoidance due to larger infrastructure footprint. Greatest direct loss of subsistence use areas due to increase in overall infrastructure footprint.	410.7 acres using 5.2 million cubic yards of gravel 397.9 acres of wetlands and WOUS fill 9,052.3 acres of disturbance for birds[a] (4,690.6 in high-use areas) Least potential for subsistence hunter avoidance due to infrastructure footprint. Least direct loss of subsistence use areas due to reduction in overall infrastructure footprint.
Location of Willow processing facility, operations center, and airstrip	Perceived differences in air quality effects (Alternative C would be closer to Nuiqsut) Disturbance and displacement of caribou (some Alternative C components would be in an area of lower caribou density)	WPF colocated with BT3 The infield road could funnel caribou movement along the west side of the road and toward the airstrip and WPF during fall migration south.	Near the south airstrip and approximately 5 miles east of BT3 Decreased potential for deflection of migrating caribou since it would remove the perpendicular intersection of access and infield roads, which could be a pinch-point for caribou movement. Caribou are less likely to be funneled into the area by the infield road. WPF, WOC, and southern airstrip would be further east, in an area with lower densities of caribou. Because fewer caribou use this area, disturbance and displacement due to noise and human activity from these facilities would affect fewer caribou.	WPF colocated with BT3 Decreased potential for deflection of migrating caribou, especially near the WPF, since it would remove the perpendicular intersection of access and infield roads. Caribou moving south along the east side of the infield roads during southerly movements in the fall would not have to cross a road, which would lower the probability of delays or deflections.

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Ice infrastructure	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals Increased displacement or mortality of birds, caribou, and other wildlife due to increased subsistence access Changes to subsistence access	Approximately 372.0 total miles (2,074.7 total acres) of ice roads over seven construction seasons No annual resupply ice road 2,872.3 acres of ice infrastructure 1.5 acres in polar bear critical habitat Least amount of ice roads for subsistence access	Approximately 471.0 total miles (2,466.7 total acres) of ice roads: 393.0 miles over eight construction seasons 3.9 miles of annual resupply ice road (16.5 acres) (2029 to 2050; 78.0 total miles; 330.9 total acres) 3,400.3 acres of ice infrastructure 2.0 acres in polar bear critical habitat More ice roads for subsistence access	Approximately 694.5 total miles (3,442.8 total acres) of ice roads: 478.9 miles (2,528.1 acres) over nine construction seasons 9.8 miles (41.6 acres) of annual resupply ice road (2030 to 2052; 215.6 total miles; 914.7 total acres) 4,451.2 acres of ice infrastructure 1.5 acres in polar bear critical habitat Most miles of ice road for subsistence access
Pipelines	Changes to undisturbed characteristic visual landscape including night skies Habitat alteration for birds, caribou, and polar bears Collision potential for birds Delayed or deflected movement of caribou from new linear infrastructure Increased insect relief habitat for caribou Increased spill risk	96.3 total miles of pipeline rack 93.2 miles on new VSMs 3.1 miles on existing VSMs 0.8 mile HDD 267.0 total miles of individual pipelines 0 miles of pipeline without a parallel road Other pipelines: 67.1-mile seawater pipeline 34.0-mile diesel pipeline Diesel trucked by road: 38.8 miles	97.7 total miles of pipeline rack 94.3 miles on new VSMs 3.4 miles on existing VSMs 0.8 mile HDD 336.5 total miles of individual pipelines 3.9 miles of pipeline without a parallel road Other pipelines: 61.7-mile seawater pipeline 68.9-mile diesel pipeline Diesel trucked by road: 0 miles	95.6 total miles of pipeline rack 92.2 miles on new VSMs 3.4 miles on existing VSMs 0.8 mile HDD 293.8 total miles of individual pipelines 9.8 miles of pipeline without a parallel road Other pipelines: 66.9-mile seawater pipeline 72.8-mile diesel pipeline Diesel trucked by road: 0 miles

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Gravel roads	Changes to undisturbed characteristic visual landscape Upslope water impoundment and thermokarst erosion Potential blockage or restriction of sheet flow during spring breakup, that could result in changed flow direction, channel instability, erosion of the tundra or stream channel, or deposition of sediment on the tundra or in the stream channel Disturbance and displacement of birds, caribou, and polar bears Delayed or deflected movement of caribou from new linear infrastructure Changes to subsistence access and resource availability	38.2 total miles (285.3 total acres, including turnouts) Eight turnouts with subsistence/tundra access ramps (3.0 acres total) Most gravel roads for subsistence access	36.8 total miles (273.5 total acres, including turnouts) Seven vehicle turnouts with subsistence/tundra access ramps (2.6 acres total) Fewer gravel roads for subsistence access	28.3 total miles (211.9 total acres, including turnouts) Six turnouts with subsistence/tundra access ramps (2.2 acres total) Fewest gravel roads for subsistence access
Dust shadow from gravel roads[b]	Soil composition changes, decreased albedo, permafrost thawing, thermokarst development Vegetation damage Wetland composition changes Habitat alteration for fish, birds, caribou, and polar bears	3,466.6 total acres (includes mine site)	3,514.9 total acres (includes mine site)	2,700.2 total acres (includes mine site)
Stream crossings (culverts and bridges)	Hydrologic changes or erosion Perceived potential contamination of fish and thus decreased subsistence resource availability Increased noise during construction Changes to undisturbed characteristic visual landscape Habitat loss for fish	18 crossings: 7 bridges 11 culvert batteries 56 bridge piles below OHW (52 in anadromous streams) 14 VSMs below OHW	16 crossings: 6 bridges 10 culvert batteries 36 bridge piles below OHW (32 in anadromous streams) 32 VSMs below OHW	14 crossings: 6 bridges 8 culvert batteries 52 bridge piles below OHW (48 in anadromous streams) 14 VSMs below OHW

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Airstrip	Increased noise Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears	1 airstrip and apron (39.3 acres) near BT3/WPF	2 airstrips (78.6 total acres): North airstrip and hangar (39.3 acres) near BT2 South airstrip and apron (39.3 acres), approximately 5 miles east of BT3	1 airstrip and apron (39.3 acres) near BT3/WPF
Total freshwater use	Temporary changes to lake-water chemistry (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity Habitat alteration for fish and birds Special status species: yellow-billed loon nesting lakes	1,874.0 million gallons over the life of the Project (30 years)	2,047.2 million gallons over the life of the Project (30 years)	2,433.8 million gallons over the life of the Project (32 years)
Ground traffic[c, d,]	Increased noise Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears Injury or mortality of birds, caribou, and polar bears	3,009,933 vehicle trips	2,340,368 vehicle trips	3,187,363 vehicle trips
Fixed-wing air traffic[c, ef]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	35,713 total flights Willow: 34,464 Alpine: 1,249	36,183 total flights South Willow: 29,096 North Willow: 5,838 Alpine: 1,249	45,398 total flights Willow: 41,967 Alpine: 3,431
Helicopter air traffic[c]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	2,478 total flights Willow: 2,337 Alpine: 141	3,025 total flights South Willow: 2,327 North Willow: 572 Alpine: 126	4,658 total flights Willow: 4,476 Alpine: 182

Project Component	Resources Affected	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Human activity	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals	30-year Project duration (7 years of construction) 853.5 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	30-year Project duration (8 years of construction) 857.5 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)	32-year Project duration (9 years of construction) 851.5 acres of polar bear disturbance (potential terrestrial denning habitat within 1 mile of winter activity, USFWS buffer)
Greenhouse gas emissions	Climate change and air quality (GHG emissions for the Project duration are measured as CO_2e in Mt/annual average)	Total GHG emissions are 261,419 Mt of CO_2e for 30-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,714 Mt CO_2e per year) constitute approximately 0.135% of the 2017 U.S. GHG inventory.	Total GHG emissions are 263,816 Mt of CO_2e for 30-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,794 Mt CO_2e per year) constitute approximately 0.136% of the 2017 U.S. GHG inventory.	Total GHG emissions are 262,712 Mt of CO_2e for 32-year Project duration (using 100-year GWP, IPCC AR4) Annual average total (i.e., sum of direct and indirect) GHG emissions (8,210 Mt CO_2e per year) constitute approximately 0.127% of the 2017 U.S. GHG inventory.

Note:AR4 (Fourth Assessment Report); BT2 (drill site BT2); BT3 (drill site BT3); CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); HDD (horizontal directional drilling); IPCC (Intergovernmental Panel on Climate Change); Mt (thousand metric tons); OHW (ordinary high water); USFWS (U.S. Fish and Wildlife Service); VSM (vertical support members); WOC (Willow Operations Center); WOUS (Waters of the U.S.); WPF (Willow processing facility)

[a] Based on a 656-foot (200-meter) disturbance zone around gravel facilities.

[b] Area potentially altered by dust generated from vehicles or wind on gravel fill extending 328 feet (100 meters) from gravel infrastructure.

[c] Total traffic is for the life of the Project (Alternatives B and C, 30 years; Alternative D, 32 years) and does not include any reclamation activity. Ground-traffic trips are one-way. A single flight is defined as a landing and subsequent takeoff, and a single vessel trip is defined as docking and subsequent departure.

[d] Number of trips includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Construction ground traffic also includes gravel hauling (e.g., B70 or maxi dump trucks).

[e] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse); includes C-130, Twin Otter or CASA, Cessna, and DC-6 or similar aircraft.

Table ES.2. Summary Comparison of Key Impacts by Sealift Module Delivery Option

Component	Resources Affected	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Total gravel footprint and gravel fill volume	Loss of gravel resources Changes to undisturbed characteristic visual landscape including night skies WOUS lost Habitat loss and disturbance and displacement for fish, birds, and marine mammals Subsistence harvester avoidance	12.8 acres 397,000 million cubic yards	13.0 acres 446,000 million cubic yards

Component	Resources Affected	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Location	Disturbance and displacement of caribou Subsistence harvester avoidance Reduced availability of subsistence resources (Ranked the same for subsistence since there are positive and negative outcomes for each location)	2.4 miles offshore Farther offshore from high-density caribou area. Greatest potential for offshore avoidance by Nuiqsut hunters. Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected); impacts may occur for Utqiagvik but are less likely (up to 12% directly affected).	0.6 mile offshore In an area of high use by caribou for insect relief (end of June to beginning of August). Closer to Teshekpuk Lake. Could disturb more caribou, especially in July. Would reduce caribou availability. Greater potential for indirect impacts to caribou, wolf, and wolverine resource availability for Utqiagvik harvesters. Less potential for impacts to Nuiqsut harvester access since island would be farther from core Nuiqsut seal, eider, and coastal caribou harvesting areas. Impacts are most likely to occur for Nuiqsut harvesters (up to 94% directly affected); impacts may occur for Utqiagvik but are less likely (up to 24% directly affected). More likely to cause indirect impacts to Utqiagvik harvesters because of its proximity to key Utqiagvik harvesting areas at Teshekpuk Lake.
Closest proximity of summer construction to high-density caribou post-calving	Disturbance and displacement of caribou	12.3 miles	2.4 miles Greater disturbance of caribou during post-calving
Closest proximity of summer construction to high-density caribou mosquito relief	Disturbance and displacement of caribou	9.6 miles	0.5 miles Greater disturbance of caribou during insect relief
Closest proximity of summer construction to high-density caribou oestrid fly relief	Disturbance and displacement of caribou	1.3 miles	0.0 miles Greater disturbance of caribou during insect relief
Ice roads	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals	117.1 total miles (1,337.5 acres) Total gravel haul (1 season): 35.7 miles on tundra; 2.4 miles on sea ice	229.7 total miles (2,592.6 acres) Total gravel haul (1 season): 77.9 miles on tundra; 0.6 miles on sea ice Total module transport (2 seasons): 150.0 miles on tundra; 1.2 miles on sea ice

Component	Resources Affected	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
	Increased displacement or mortality of birds, caribou, and other wildlife due to increased subsistence access. Changes to subsistence access	Total module transport (2 seasons): 74.2 total miles on tundra; 4.8 miles on sea ice 378.3 acres of ice in polar bear terrestrial denning critical habitat Greater potential for hunter avoidance of infrastructure due to presence of ice roads in key Nuiqsut geese hunting areas along Fish Creek.	189.9 acres of ice in polar bear terrestrial denning critical habitat More forage damage for caribou
Multi-season ice pads	Potential impoundments during spring breakup Vegetation and soil compaction Habitat alteration for birds, caribou, and marine mammals	Three 10.0-acre multi-season ice pads: One at BT1 One near Atigaru Point One midway between Atigaru Point and BT1	Three 10.0-acre multi-season ice pads: One at BT2 Two along ice road between BT2 and Point Lonely More potential to affect caribou in summer because more caribou use the area closer to Point Lonely
Total freshwater usage	Temporary changes to lake-water chemistry (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity Habitat alteration for fish and birds Special status species: yellow-billed loon nesting lakes	521.2 million gallons	1,004.9 million gallons
Ground traffic [a]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and polar bears Injury or mortality of birds	2,306,087 trips	2,846,987 trips
Fixed-wing traffic[b]	Changes to undisturbed characteristic visual landscape including night skies Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	200total flights (winter): Willow: 150 Alpine: 50	320 total flights (96 to Point Lonely in summer): Willow: 230 Alpine: 90 Markedly greater disturbance of caribou during insect relief
Helicopter traffic	Changes to undisturbed characteristic visual landscape including night skies	450 total flights Willow: 330	450 total flights Willow 330

Component	Resources Affected	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
	Disturbance and displacement of birds, caribou, and marine mammals Injury or mortality of birds	Alpine: 120	Alpine 120
Sealift barge traffic	Disturbance and displacement of fish, birds, and marine mammals	6 barges ~600 more miles of sealift barge traffic[c]	6 barges
Support vessel traffic[d]	Disturbance and displacement of fish, birds, and marine mammals	224	224 ~22,400 more miles of support vessel traffic[c]
120-foot-tall communication tower	Injury or mortality of birds	2 towers	3 Towers
Human activity (construction camps with 100-person capacity)	Disturbance and displacement of birds, caribou, and marine mammals	Camp for winter ice road construction (each season) on a multi-season ice pad Camp for module offload and transport on multi-season ice pad at Atigaru Point Camp for summer construction and module receipt would be located on a barge (i.e., Floatel) at module transfer island	Camp for winter ice road construction (each season) on existing gravel pad Camp for module offload and transport at Point Lonely on existing gravel pad Camp for summer construction and module receipt at Point Lonely on existing gravel pad Markedly greater disturbance of caribou because activity would be onshore in summer in a location with more caribou.

Note: BT1 (drill site BT1); BT2 (drill site BT2); WOUS (Waters of U.S.). Traffic trips are defined as one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as a docking and subsequent departure.
[a] Includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Ground transportation also includes gravel hauling operations (i.e., B70 or maxi dump trucks) and module transportation.
[b] Flights outlined are additional flights required beyond projected travel to/from existing airstrips and include flights to the Alpine and Willow airstrips. Fixed-wing aircraft includes C-130, DC-6, Twin Otter or CASA, Cessna, or similar.
[c] Both options would have the same number of trips, but distance traveled would vary by option. Atigaru Point is approximately 50 miles from Point Lonely. Six round-trip barge trips over that distance is 600 miles. Barges would travel from southern Alaska. Support vessels would originate at Oliktok Point; 224 round-trip support vessel trips over 50 miles is 22,400 miles.
[d] Includes crew boats, tugs supporting sealift barges, and other support vessels.

8.0 COLLABORATION AND COORDINATION

The BLM is the lead agency for this EIS. Cooperating agencies include the USACE, U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), U.S. Coast Guard, U.S. Department of Transportation (Pipeline and Hazardous Material Administration), Native Village of Nuiqsut (NVN), the Iñupiat Community of the Arctic Slope, City of Nuiqsut, North Slope Borough, and State of Alaska. The Federal Aviation Administration, Bureau of Ocean Energy Management, and National Marine Fisheries Service (NMFS) were invited to be cooperating agencies but declined to participate.

The BLM also worked closely with the Air Quality Technical Working Group (as per the 2011 Memorandum of Understanding among the U.S. Department of Agriculture, U.S. Department of the Interior, and EPA regarding Air Quality Analyses [USDA et al. 2011]). This group provided feedback on air quality modeling and the subsequent air quality impact analysis.

As the lead federal agency, the BLM consulted with federally recognized tribal governments during preparation of the EIS. The BLM initiated the government-to-government consultation and Alaska Native Claims Settlement Act (ANCSA) corporation consultation with the following tribes and ANCSA corporations whose members could be substantially affected by the Project:

- Native Village of Nuiqsut
- Naqsragmiut Tribal Council
- Iñupiat Community of the Arctic Slope
- Kuukpik
- Arctic Slope Regional Corporation

The BLM offered these entities the opportunity to participate in formal consultation, to participate as cooperating agencies, or simply to receive information about the project, prior to public dissemination.

The BLM is consulting with the Alaska State Historic Preservation Office, in accordance with Section 106 of the National Historic Preservation Act of 1966. This is to determine if and how the Project could affect cultural resources listed in or eligible for listing in the National Register of Historic Places.

To comply with Section 7(a)(2) of the Endangered Species Act of 1973 (ESA), the BLM began coordinating with the USFWS and NMFS early in the EIS process. Both provided input on issues, data collection and review, and alternatives development. The BLM will consult with the USFWS and NMFS to identify ESA issues and to develop the biological assessment.

The BLM's preliminary evaluation of the effects of the Project on subsistence uses and needs as required under Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA) is included in Appendix G, *810 Analysis*. The BLM's draft finding concludes that development of the Project is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. However, the evaluation concludes that development of the Project "may significantly restrict" uses for the community of Nuiqsut, due to a reduction in the availability of resources caused by alteration of their distribution, and a limitation on subsistence user access to the area.

An ANILCA Section 810 notice will be published concurrent with the EIS and a public hearing will be held in Nuiqsut during the public meeting for the Draft EIS.

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1.0 INTRODUCTION AND PURPOSE AND NEED

This Environmental Impact Statement (EIS) has four volumes:

- Volume 1: Executive Summary and Chapters 1 through 5
- Volume 2: Appendix A – Figures
- Volume 3: Appendices B through E.3
- Volume 4: Appendices E.4 through I

Appendix E contains the technical information for all resource chapters and is numbered in the same order as the resource chapters (Appendix E.2 is the technical appendix for Section 3.2 of the EIS). All glossary terms are bolded upon first use. A full glossary follows the EIS.

1.1 Introduction

The Bureau of Land Management (BLM) received a request from ConocoPhillips Alaska, Inc. (the Proponent) on May 10, 2018, to prepare the Willow Master Development Plan (MDP) EIS. The EIS would facilitate the permitting process for the proposed development of hydrocarbon resources from federal oil and gas leases in the northeast area of the National Petroleum Reserve in Alaska (NPR-A). The MDP addresses infrastructure components that would be constructed for the purpose of oil and gas development. If the MDP is approved, the Proponent may submit permit applications for up to five drill sites, a central processing facility, an operations center pad, up to 38.2 miles of gravel roads, up to 698.8 total miles of ice roads during construction and up to 225.4 total miles of resupply ice roads during operations, 1 to 2 airstrips, up to 336.5 miles of pipelines (94.3 miles of new pipeline rack), and a gravel mine site on federal land in the NPR-A. In addition, the Proponent would submit applications to the State of Alaska (State) for a module transfer island (MTI) on State submerged lands. Actions on both state and federal lands are considered in the EIS. The Willow MDP Project (Project) is anticipated to have a peak production of 130,000 barrels of oil per day over its 30-year life (producing approximately 590 million barrels of oil).

As the federal manager of the NPR-A, the BLM is responsible for land-use authorizations and compliance with the requirements of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.). Additionally, the U.S. Army Corps of Engineers (USACE), a cooperating agency, also has authority over the Project through its authority to issue or deny permits for the placement of dredge or fill material in **Waters of the United States** (WOUS), including wetlands. The 10 cooperating agencies for the Project and their roles and expertise are described below.

The Proponent's stated purpose for the Project is to construct drill sites, roads, pipelines, and ancillary facilities to support the safe and economic production and transportation to market of oil and gas resources under leaseholds in the NPR-A. The Project would help offset declines in production from the North Slope oil fields and contribute to the local, state, and national economies.

1.2 National Petroleum Reserve in Alaska

The Naval Petroleum Reserve Number 4 was created by President Warren G. Harding in 1923 to protect a future oil supply for the U.S. Navy. In 1976, the Naval Petroleum Reserves Production Act (NPRPA) renamed the Reserve the NPR-A and transferred its management to the Secretary of the Interior (Secretary). The NPRPA (as amended) requires the Secretary to conduct oil and gas leasing in the NPR-A and provides the Secretary with the authority to implement such regulations as deemed necessary for the protection of important surface resources and uses.

Congress authorized petroleum production in the NPR-A in 1980 (PL 96-514), but it was not until the 1990s that development on adjacent state lands made exploration in the NPR-A economically feasible. In 1998, BLM completed an Integrated Activity Plan (IAP) that assessed the potential use of the Northeast NPR-A for oil development (BLM 1998). The 1998 IAP was amended in 2005 and supplemented in 2008 (BLM 2005, 2008c). In 2012, the BLM completed an IAP/EIS that analyzed development scenarios and related environmental consequences for all BLM-managed federal lands and oil and gas resources within the NPR-A (BLM 2012b). The IAP/EIS ROD was issued in 2013 (BLM 2013a). The Willow MDP EIS tiers to the 2012 IAP/EIS and 2013 ROD.

1.3 Purpose and Need

The purpose of the Proposed Action is to construct the infrastructure necessary to allow the production and transportation to market of federal oil and gas resources under leaseholds in the northeast area of the NPR-A, consistent with the proponent's federal oil and gas lease and unit obligations. The need for federal action (i.e., issuance of authorizations) is established by BLM's responsibilities under various federal statutes, including the NPRPA (as amended); Mineral Leasing Act, and the Federal Land Policy and Management Act, as well as various federal responsibilities of cooperating agencies under other statutes, including the Clean Water Act (CWA). Under NPRPA, the BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). The BLM is required to respond to the Proponent's requests for an MDP and related authorizations to develop and produce petroleum in the NPR-A.

The USACE, as a cooperating agency on this EIS, develops their own overall purpose for the project in accordance with their Section 404 Clean Water Act regulations. The overall purpose of the Project, as defined by the USACE, is to construct infrastructure to safely produce, process, and transport commercial quantities of liquid hydrocarbons to market via pipeline from the Willow reservoir. The overall Project purpose and need allows a robust consideration of alternatives while providing a foundation to determine practicability, which is a key aspect of the USACE's Section 404 permitting process. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall Project purposes (40 CFR 230.10(a)(2)).

The purpose and need of the Proposed Action is a key factor in determining a range of alternatives required for consideration in an EIS and assists with the selection of a preferred alternative. The Draft EIS (DEIS) presents a reasonable range of alternatives that consists of a No Action Alternative and three action alternatives. The DEIS analyzes the environmental impacts of these alternatives and informs how well each alternative meets the project purpose and need.

1.3.1 Decision to be Made

The BLM and other authorizing cooperating agencies will decide whether to authorize the Proposed Action, in whole or in part, based on the analysis contained in this EIS. The ROD(s) associated with this EIS will not constitute the final approval for all actions, such as approval for subsequent individual applications for permits to drill and rights-of-way associated with the Proposed Action. The EIS analysis does, however, provide the BLM and other federal agencies that have regulatory oversight and permitting authorities with information and NEPA analysis that could be used to inform final approvals for individual project components, such as permits to drill and rights-of-way.

1.4 Development Location (Project Area)

The Willow MDP area (Project area or Willow area) is located on the North Slope of Alaska, with the majority of the proposed facilities on leased federal lands within the Bear Tooth Unit (BTU) in the northeastern portion of the NPR-A (Figure 1.4.1). Supporting infrastructure, including road connections, pipeline tie-ins, the MTI, and the gravel mine site would be located on federal and Native corporation–owned lands in the Greater Mooses Tooth (GMT) Unit, on non-unitized lands within the NPR-A, and on lands or waters owned and managed by the State. None of the facilities would be located on or near Native allotments. Where possible, Project pipelines would be colocated with existing pipelines on federal, State, and Native corporation land.

Elements of the Project would occur within the Teshekpuk Lake Special Area (TLSA) of the NPR-A, which was designated by the Secretary in 1977 for its significant value to waterfowl and shorebirds. The designation has since been expanded to protect caribou, waterbirds, shorebirds, and their habitats.

1.5 Cooperating Agencies

The BLM is the lead agency for this EIS. Ten federal, regional, or local organizations have been invited to participate as cooperating agencies (Table 1.5.1).

Table 1.5.1. Invited Cooperating Agencies and Their Authorities and Expertise

Agency	Authority/Expertise
U.S. Army Corps of Engineers	Permit authority for Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act
U.S. Environmental Protection Agency	Responsibilities under the Clean Air Act, the Clean Water Act, and the Oil Pollution Act
U.S. Fish and Wildlife Service	Responsibilities under the Endangered Species Act, expertise in fish and wildlife
U.S. Coast Guard	Permit authority for bridges over navigable waters
U.S. Department of Transportation, Pipeline and Hazardous Material Administration	Responsible for pipeline safety, inspection, and protection
Native Village of Nuiqsut	Expertise in sociocultural, wildlife, subsistence, and economic resources
Iñupiat Community of the Arctic Slope	Expertise in sociocultural, subsistence, and economic resources
City of Nuiqsut	Expertise in sociocultural and economic resources
North Slope Borough	Responsible for land use planning and regulation, permit authority for rezone, expertise in sociocultural, wildlife, subsistence, and economic resources
State of Alaska (Departments of Fish and Game; Environmental Conservation; Natural Resources; Health and Social Services; and Commerce, Community, and Economic Development)	Responsible for adjudicating requests or applications for permits, easements, and leases on state land (including state submerged land within three miles of the coast). Authority for air, water use, and wastewater permits, expertise in sociocultural, human health, wildlife, subsistence, economic resources, off-road travel, and ice road construction

1.6 Other Agencies

The Federal Aviation Administration, Bureau of Ocean Energy Management, and National Marine Fisheries Service were invited to be cooperating agencies but declined to participate.

The BLM also worked closely with the Air Quality Technical Working Group (as per the 2011 Memorandum of Understanding among the U.S. Department of Agriculture [USDA], U.S. Department of the Interior, and U.S. Environmental Protection Agency regarding Air Quality Analyses [USDA et al. 2011]). This group provided feedback on air quality modeling and the Air Quality Technical Support Document.

1.7 Permitting Authorities

In proposing to undertake an action (e.g., issue an authorization), federal agencies are required under NEPA to analyze the reasonably foreseeable environmental impacts. If more than one authorizing federal agency is involved in a related action, a single NEPA document may be developed to meet the requirements of all federal agencies. All action alternatives and module delivery options in this EIS would require authorization by the BLM, U.S. Army Corps of Engineers (USACE), and the U.S. Coast Guard.

The State of Alaska, North Slope Borough, Kuukpik Corporation, Native Village of Nuiqsut, and Arctic Slope Regional Corporation are responsible for land management decisions, easements, leases, authorizations, and permits on their respective lands. The State of Alaska also has authority for state waters within 3 miles of the shore.

Appendix C, *Regulatory Authorities and Framework*, provides a full list of anticipated permits, approvals, and consultations as well as a list of applicable federal laws and executive orders.

1.8 Scoping and Substantive Issues

The BLM identified substantive issues to be addressed in the Willow MDP EIS through public and agency scoping (including internal BLM scoping), and consultation with Alaska Native tribes (Appendix B, *Public Engagement and Scoping Summary Report*). The original scoping period was 30 days; however, it was extended by 14 days due to public requests and officially ended on September 20, 2018. The community of Nuiqsut was given an additional 8 days to comment, for a total of 52 days. Public scoping meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Fairbanks, Nuiqsut, and Utqiaġvik.

During scoping, 1,430 comment submissions were received, with 377 comments being unique. Comments were categorized as issues associated with resource topics, issues associated with BLM policy (and therefore not addressed in the EIS), or out-of-scope comments. Substantive issues were identified as those that could potentially have significant effects, are necessary to make a reasoned choice among alternatives, or are needed to address points of disagreement, debate, or dispute regarding an anticipated impact from the Project. Substantive issues within the scope of the EIS that were identified through scoping are addressed in the EIS in Chapter 3.0, *Affected Environment and Environmental Consequences*.

Resources and topics that were considered but dismissed from detailed analysis in the EIS are listed in Table 1.8.1, along with the rationale for dismissal.

Table 1.8.1. Resources and Topics Dismissed from Detailed Analysis

Resource or Topic	Rationale for Dismissal from Detailed Analysis
Wildland fire	The Project is located above the latitudinal tree line, in a predominantly wetland environment where wildland fire is rare.
Sand resources	Sand resources would not be used for the Project and thus would not be affected.
Physiography and geomorphology	The dominant physiographic feature near the Project is the Arctic Coastal Plain; the Project would not alter the geography or geomorphology of this. The only geomorphic feature that could be affected is permafrost, which is included in detailed analysis.
Cultural and paleontological resources	The Project area was surveyed for cultural and paleontological resources (Reanier 2019b; supplemental report forthcoming in November 2019), and the Proponent routed all Project components (including ice roads and pads) 500 feet or farther from known resources to avoid adversely impacting any such areas. To ensure appropriate treatment of inadvertent discoveries, the Proponent maintains a Fossil and Artifact Finds Standard Operating Procedure and requires awareness training as required under BMP I-1 of the NPR-A IAP (BLM 2013a). Although increased access to cultural resources has been documented to correlate strongly with increased instances of vandalism and looting of cultural resources sites (Hedquist, Ellison et al. 2014; Spangler, Arnold et al. 2006), these impacts are improbable due to conditions specific to the Project area and timeline. Ice roads and pads would only be used during winter construction seasons, during which time any nearby cultural resources would be inaccessible due to snow cover. Access to cultural resources areas via gravel infrastructure in the summer months, while possible, would be made complicated by the surrounding terrain. The cultural resources and paleontological sites within 2.5 miles of the Project are also not of the type(s) typically considered valuable to looters and are therefore less likely to warrant transit of the landscape, which is suboptimal for transit by foot or vehicle. Additional supporting detail is provided in Appendix F.2, *Section 106 Cultural Resources Findings: Process and Analysis*.
Recreation	Current recreation use is very low, and prospective future use of this area for recreation is also low.
Wild and scenic rivers	There are no rivers eligible for designation as Wild and Scenic near the Project.

Note: BMP (best management practice); IAP/EIS (Integrated Activity Plan/Environmental Impact Statement); NPR-A (National Petroleum Reserve in Alaska); Project (Willow Master Development Plan Project)

1.9 Consultation and Coordination

1.9.1 Endangered Species Act Consultation

Consultation under Section 7 of the Endangered Species Act (ESA) will occur between federal authorizing agencies and the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) as appropriate, for species listed under the ESA. Consultation will occur parallel to the NEPA process and will be completed prior to the issuance of any Record of Decision.

1.9.2 Magnuson-Stevens Fishery Conservation and Management Act Coordination

Coordination under the Magnuson-Stevens Fishery Conservation and Management Act regarding essential fish habitat will occur between federal authorizing agencies and NMFS as appropriate, parallel to the NEPA process.

1.9.3 National Historic Preservation Act Section 106 Consultation

Consultation under Section 106 of the National Historic Preservation Act was initiated on November 23, 2018, with the State Historic Preservation Office and tribes. The BLM will continue consultation throughout the EIS process.

1.9.4 Tribal Consultation

The BLM initiated the government-to-government consultation and Alaska Native Claims Settlement Act (ANCSA) corporation consultation with the following tribes and ANCSA corporations whose members could be substantially affected by the Project:

- Native Village of Nuiqsut
- Naqsragmiut Tribal Council
- Iñupiat Community of the Arctic Slope
- Kuukpik Corporation
- Arctic Slope Regional Corporation

Government-to-government consultation meetings have been held regularly with the Native Village of Nuiqsut. The Native Village of Nuiqsut is also participates in regularly scheduled Working Group meetings for the National Petroleum Reserve in Alaska. Kuukpik Corporation and the Arctic Slope Regional Corporation have engaged in regular consultation with the BLM during the NEPA process to date.

1.10 Compliance with the Alaska National Interest Lands Conservation Act Section 810

The BLM's preliminary evaluation of the effects of the Project on subsistence uses and needs as required under Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA) is included in Appendix G, *ANILCA 810 Analysis*. The BLM's draft finding concludes that the Project is not expected to result in a large reduction in the abundance (population level) of caribou or any other subsistence resource. Neither is there any expectation that there will be a major increase in the harvest of caribou by non-subsistence users. However, the evaluation concludes that the Project may significantly restrict uses for the community of Nuiqsut, due to:

- reduction in the availability of resources caused by alteration of their distribution, and
- limitation on subsistence user access to the area.

An ANILCA Section 810 notice will be published concurrent with the EIS and a public hearing will be held in Nuiqsut during the public meeting for the Draft EIS.

2.0 ALTERNATIVES

2.1 Introduction

This chapter describes Willow MDP Project components and the alternatives under consideration in the EIS. A detailed description of Project components and alternatives, including the alternatives development process, is available in Appendix D, *Alternatives Development*.

2.2 Alternatives Development

Following Project scoping, the BLM convened a series of alternatives development meetings with the EIS cooperating agencies. These meetings identified a range of options for the Project or its constituent components; the Project components that options were identified for include access, airstrips, MTI, mine site, gravel pads, and processing facility. This process and the initial range of alternatives are detailed in Appendix D, *Alternatives Development*. Alternative B (Section 2.4.2, *Alternative B: Proponent's Project*) was developed by ConocoPhillips Alaska, Inc. (CPAI), and Alternatives C and D (Sections 2.4.3, *Alternative C: Disconnected Infield Roads*, and 2.4.4, *Alternative D: Disconnected Access*) were developed by the BLM and EIS cooperating agencies.

This chapter describes the range of alternatives developed for detailed analysis in the EIS and includes the No Action Alternative (Alternative A) and three action alternatives (B, C, and D); additionally, two options are included for sealift module delivery. All action alternatives were evaluated for their ability to meet the overall Project purpose and need (Section 1.3, *Purpose and Need*); are "practical or feasible from a technical and economic standpoint and using common sense" (CEQ 1981); address resource impacts or conflicts; and do not substantially have the same impacts of other alternatives being considered.

2.3 Alternative Components Considered but Eliminated from Further Analysis

The alternatives development meetings held with cooperating agencies resulted in consideration of several alternative components to the Proponent's Project. Alternative components were evaluated against screening criteria, including how well they meet the purpose and need, their ability to reduce impacts or resource conflict (particularly for key resources and issues raised during scoping), feasibility (technological, logistical, and economical), practicability (as defined by CWA Section 404 regulations), and common sense (as provided by Council on Environmental Quality guidelines). These terms, as defined under the NEPA and CWA Section 404 regulations, are further explained in Appendix D, *Alternatives Development*. The alternative elements considered but eliminated from further analysis in the EIS are described in Appendix D.

2.4 Reasonable Range of Alternatives

Four alternatives are analyzed in detail in the EIS:

- Alternative A: No Action
- Alternative B: Proponent's Project (Figure 2.4.1)
- Alternative C: Disconnected Infield Roads (Figure 2.4.2)
- Alternative D: Disconnected Access (Figure 2.4.3)

Action alternatives (B, C, and D) presented in the EIS include variations on specific Project components (e.g., Project access). The range of alternatives was developed to address the resource impact issues and conflicts identified during internal scoping with the BLM Interdisciplinary Team and external scoping with the public and cooperating agencies. Additionally, two options are presented for how sealift modules (required for all action alternatives) would be delivered to the Project (Section 2.7, *Sealift Module Delivery Options*); either module delivery option could be paired with any action alternative:

- Option 1: Proponent's Module Transfer Island (Figure 2.4.4)
- Option 2: Point Lonely Module Transfer Island (Figure 2.4.5)

2.4.1 Alternative A: No Action

Under the No Action Alternative, the Project would not be constructed; however, oil and gas exploration in the area would continue. Under the NPRPA, the BLM is required to conduct oil and gas leasing and development in the NPR-A (42 USC 6506a). The No Action Alternative would not meet the Project's purpose and need but is included for detailed analysis to provide a baseline for the comparison of impacts of the action alternatives (BLM 2008, Section 6.6.2, *No Action Alternative*; 40 CFR 1502.14(d)).

2.4.2 Alternative B: Proponent's Project

Alternative B would extend an all-season gravel road from the Greater Mooses Tooth 2 (GMT-2) development southwest toward the Project area (Figure 2.4.1). The access road would end at the Willow processing facility (WPF), which would be colocated with Bear Tooth drill site 3 (BT3), and adjacent to an airstrip and the Willow Operations Center (WOC). Gravel roads would extend north (connecting to Bear Tooth drill sites 1, 2, and 4 [BT1, BT2, BT4]) and south (connecting to Bear Tooth drill site 5 [BT5]) of the access road. From the infield road to BT5, a water-source access road would extend east to a water source access pad and water intake system. Just east of the airstrip, an infield road would extend north, crossing Judy (Iqalliqpik) Creek before reaching BT1. From BT1, the road would continue north, crossing Judy (Kayyaaq) Creek, to reach BT2 before crossing Fish (Uvlutuuq) Creek and ending outside the eastern boundary of the K-5 Teshekpuk Lake Caribou Habitat Area at BT4. Alternative B would construct 7 bridges. Infield (multiphase) pipelines would connect individual drill sites to the WPF, and export/import pipelines would connect the WPF to existing infrastructure on the North Slope.

Sealift module delivery to the Project area from a module delivery location at Atigaru Point or Point Lonely would be required (Section 2.7, *Sealift Module Delivery Options*).

The access road alignment would provide direct gravel-road access from the existing gravel road network in the GMT and Alpine developments to the Project facilities. Alternative B is BLM's preferred alternative. The identification of a preferred alternative does not constitute a commitment or decision; if warranted, the BLM may select a different alternative than the preferred alternative in its ROD.

2.4.3 Alternative C: Disconnected Infield Roads

Alternative C would have the same gravel access road between GMT-2 and the Project area as Alternative B, but it would not include a gravel road connection from the WPF to BT1 (Figure 2.4.2). Thus, there would be no gravel road between these facilities or a bridge across Judy (Iqalliqpik) Creek; however, a gravel road would connect BT1 with BT2 and BT4 using the same alignment as Alternative B. Alternative C would construct 6 bridges. A second airstrip, storage and staging facilities, and camp would be located near BT2 to accommodate the personnel and materials transported between the South WOC and BT1, BT2, and BT4. An annual ice road would be constructed along the Alternative B access road alignment to allow for the movement of large equipment and consumable materials to the three disconnected drill sites (3.9 miles). Infield pipelines would connect all drill sites to the WPF; a diesel pipeline would provide fuel from Kuparuk CPF2 to the North and South WOCs; and export/import lines would connect the WPF to existing infrastructure on the North Slope.

Under Alternative C, the WPF, South WOC, and primary Project airstrip would be located approximately 5 miles east of their location in Alternative B, near the GMT and BTU boundary. Sealift module delivery to the Project area from a module delivery location at Atigaru Point or Point Lonely would be required (Section 2.7).

The intent of Alternative C is to reduce effects to caribou movement and decrease the number of stream crossings required; this is also intended to further reduce impacts to **subsistence** users of these resources. This alternative removes a portion of the road (versus Alternatives B and D) that would cross Judy (Iqalliqpik) Creek which could impede caribou movement across linear features (i.e., this alternative would avoid the junction of two roads, which could be a pinch point that deflects caribou movement). This alternative would also reduce linear gravel infrastructure in the Project area, which may reduce impacts to hydrology (e.g., sheet flow) and wetlands (e.g., direct fill, fugitive dust).

2.4.4 Alternative D: Disconnected Access

Alternative D would colocate the WPF with BT3 (like Alternative B), construct four additional drill sites (five total drill sites), the WOC, pipelines and valve pads, gravel roads connecting the drill sites to the WPF/BT3, and an airstrip (Figure 2.4.3). However, Alternative D would not connect the Project area with an all-season gravel access road to GMT or the Alpine developments; but it would employ the same gravel roads as proposed under Alternative B connecting drill sites and other Project infrastructure. Alternative D would require 6 bridges. Annual resupply access to the Project area would be provided by ice road connection between GMT-2 and the WPF (9.8 miles).

The lack of a gravel access road connection to Alpine would reduce the degree to which the Project could leverage existing Alpine infrastructure. As a result, additional facilities would be required in the Project area, duplicating some facilities currently at Alpine, including warehouse space; valve and fleet shops; emergency response equipment; biocide, methanol, and corrosion inhibitor storage tanks; and an incinerator. The addition of these facilities in the Project area would require additional gravel pad space at the WOC and WPF (97.1 total acres versus Alternative B 55.7 total acres). Additionally, Alternative D would require a diesel pipeline connection from Kuparuk CPF2 to the WOC (similar to Alternative C) as fuel could not be trucked to the Project area throughout the year.

Sealift module delivery to the Project area from a module delivery location at Atigaru Point or Point Lonely would be required (Section 2.7).

The intent of Alternative D is to minimize the Project's footprint and fill, reduce the number of required bridges, and lessen the length of linear infrastructure on the landscape to decrease effects to caribou movement and subsistence. This alternative's reduction of linear gravel infrastructure in the Project area may reduce impacts to hydrology (e.g., sheet flow) and wetlands (e.g., direct fill, indirect impacts from dust).

2.5 Project Components Common to All Action Alternatives

Components that are common to all action alternatives are described below; additional details on Project components are available in Appendix D, *Alternatives Development*.

2.5.1 Project Facilities and Gravel Pads

Project pads would be constructed for drill sites and support infrastructure (e.g., WPF, WOC, pipeline valve pads). Pads would be constructed of gravel fill and would be a minimum of 5 feet thick to maintain a stable thermal regime and protect underlying **permafrost** (with an average thickness greater than 7 feet). Pad thickness and gravel fill volume needed for each pad would vary depending on site-specific topography and design criteria. Embankment side slopes would be 2 horizontal to 1 vertical ratio (2:1). Erosion potential would be evaluated on a pad-specific basis, and embankment erosion protection measures would be designed and employed as necessary.

2.5.1.1 Willow Processing Facility

The WPF would include the main plant facilities for separating and processing produced multiphase fluids and delivering sales-quality crude oil. Produced water would be processed at the WPF and re-injected to the subsurface to maintain reservoir pressure. Produced natural gas would fuel plant and facility equipment, be re-injected into a producing reservoir formation to maintain reservoir pressure and be used for gas lift. Under plant startups, shutdowns, and upset conditions, natural gas may be flared.

The processing equipment at the WPF would include emergency shutdown equipment, power generators, compressors, gas treatment facilities, heat exchangers, separators, a flare system, pumps, **pigging** and metering facilities, warm storage buildings, and a tank farm. Additional equipment planned for the WPF is provided in Appendix D.

2.5.1.2 Drill Sites

The Project would construct five drill sites (at the same locations under all action alternatives). Each drill site pad has been designed and sized to accommodate all drilling and operations facilities, wellhead shelters, drill rig movement, and material storage. Each drill site is sized to accommodate at least 50 wells at a 20-foot wellhead spacing. Additional facilities typical for drill sites would include emergency shutdown equipment, well test and associated measurement facilities, pig launchers and receivers, spill response equipment, operations storage and stand-by tanks, and low- and high-pressure pipe racks.

Wells would be categorized as either production or injection. Production wells would generate the field's oil and gas production while injector wells would inject water and/or natural gas into producing formations to maintain reservoir pressure.

2.5.1.3 Willow Operations Center

The base of operations for the Project would be the WOC, located near the WPF (but separated for safety), and adjacent to the airstrip (Figures 2.4.1, 2.4.2, and 2.4.3). The WOC would contain utility buildings and storage facilities, including Willow operations camp (living quarters, offices, dining facilities, medical clinic), water and wastewater treatment plants, Class I underground injection control (UIC) disposal well(s), spill response shop, hazardous waste storage, shop space, communications infrastructure (including a tower between 60 and 200 feet tall), municipal solid waste incinerator, and helipad. (Alternative C would include a second WOC [North WOC] that would have similar infrastructure as described above.)

2.5.1.4 Valve Pads

Isolation valves would be installed on each side of pipeline crossings at Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek to minimize the potential spill impact in the event of a leak or break. To support valve infrastructure, gravel pads would be constructed on each side of the two crossings (four valve pads total).

2.5.1.5 Water Source Access Pads

Two water source access pads would be used to provide access to the freshwater intake infrastructure at Lakes M0015 and R0064 (Figures 2.4.1, 2.4.2, and 2.4.3). The pads would be sized to provide adequate space for vehicles to access the water sources and safely maneuver. The water source access pads would be connected to the Project via a water source access road from the road leading to BT5.

2.5.2 Pipelines

The Project would include infield and import/export pipelines (Figures 2.5.1, 2.5.2, and 2.5.3). Pipeline design would conform to applicable federal and state regulations, and CPAI internal criteria. All pipelines would be hydrostatically tested prior to startup. Pipelines would be located aboveground (except at road crossings and the Colville River crossing) and be nonreflective. Pipelines would be supported on horizontal support members (HSMs) that would be atop vertical support members (VSMs) placed approximately 55 feet apart. VSMs would have a typical diameter of 12 to 18 inches and disturbance footprint of 18 to 24 inches (up to 3.1 square feet). Pipelines (including suspended cables) on new VSMs would be a minimum of 7 feet above the surrounding ground surface, including in areas where new VSMs would be placed adjacent to existing Alpine pipelines, which may be less than 7 feet above the ground surface. New pipelines that share existing VSMs and HSMs would match the existing HSM heights. Where Project pipelines would parallel existing pipelines, the new VSMs would be aligned with the existing VSMs (to the extent practicable) to avoid a "picket fence" effect. Except in disconnected locations (i.e., roadless areas), pipelines would typically parallel roadways at a distance between 500 and 1,000 feet.

At Fish (Uvlutuuq) Creek, Willow Creek 4, and Judy (Iqalliqpik) Creek (except under Alternative C), pipelines would be placed on structural steel supports attached to bridge girders. At smaller stream crossings, pipelines would be installed on VSMs on each side of the crossing to avoid VSM placement in streams, to the extent practicable. Communication and power cables would be suspended from the same VSMs via messenger cable and would maintain 7 feet of clearance above the surrounding ground surface.

2.5.2.1 Infield Pipelines

Infield pipelines would carry produced fluids (oil, gas, water), injection water, gas, and miscible injectant (for enhanced oil recovery) between the WPF and each drill site. Infield pipelines would be designed to allow for inspection and maintenance (e.g., pigging). Manifold and/or pipe rack piping would combine individual wellhead piping into a common gathering line through which all produced fluids would be transported to the WPF. Pipeline designs would minimize redundant parallel pipelines to the extent practicable; for example, the infield pipeline from BT4 would tie into the BT2 infield pipelines at BT2, and BT2 pipelines would tie into BT1 pipelines at BT1 to reach the WPF at BT3 (Figures 2.4.1, 2.4.2, and 2.4.3).

2.5.2.2 Willow Pipeline

The Willow Pipeline (sales oil transport pipeline) would carry sales-quality crude oil processed at the WPF to a tie-in with the Alpine Pipeline near Alpine CD4N. From CD4N, sales-quality oil would be transported via the existing Alpine Sales Pipeline to the Kuparuk Pipeline and onward to the Trans-Alaska Pipeline System (TAPS) near Deadhorse, Alaska. The Willow Pipeline would be placed on new VSMs between the WPF and GMT-2 and on existing VSMs between GMT-2 and the tie-in pad.

2.5.2.3 Other Import/Export Pipelines

Other import/export pipelines would include seawater import, diesel import, and freshwater pipelines. The seawater pipeline would transport seawater from the Kuparuk River Unit (Kuparuk) CPF2 to the WPF. Under Alternative B, the diesel pipeline would transport diesel fuel and miscellaneous refined hydrocarbon products from Kuparuk CPF2 to the Alpine processing facility; from Alpine, diesel fuel would be trucked to the WPF and other locations in the Project area. Under Alternatives C and D, diesel fuel would be transported via pipeline from Kuparuk CPF2 to the WOC. The freshwater pipeline would transport potable water from the primary freshwater sources (Lakes M0015 and R0064) to the WOC.

The seawater and diesel pipelines would be installed beneath the Colville River (Figures 2.4.1, 2.4.2, and 2.4.3) using horizontal directional drilling (HDD). The Colville River crossing would be adjacent to existing facilities constructed for the Alpine Sales Pipeline HDD crossing and would require one new gravel pad on each side of the river. Each pipeline would be approximately 60 feet apart. Pipelines would be insulated and placed within an outer pipeline casing, which would inhibit heat transfer to permafrost, contain fluids in the event of a leak or spill, and provide structural integrity. The depth below the river channel bottom at the center of the crossing would be approximately 70 feet. The HDD crossing would be constructed during winter using ice pads on each side of the river.

2.5.3 Access to the Project Area

Access to the Project area from Alpine, Kuparuk, or Deadhorse would occur via ground transportation on ice roads, fixed-wing aircraft, and helicopter. Access from Alpine would also occur by gravel road (under Alternatives B and C). The modules comprising the processing facilities at the WPF and drill sites would be delivered to the North Slope by sealift barge and transported to the Project area over ice roads (Section 2.7, *Sealift Module Delivery Options*).

2.5.3.1 Ice Roads

Ice roads would be primarily used during Project construction to support gravel placement and pipeline construction, for lake access, and to access gravel mine site. Separate ice roads would be used for pipeline construction, gravel placement, and general traffic to address safety considerations. Ice road construction typically begins in November or December, with vehicle access via ice road depending on the ice-road season opening and closing dates and the distance from existing infrastructure. The useable ice road season for the Project area is expected to be shorter than that of Kuparuk and Alpine operations due to the logistical challenges of constructing a remote ice road. The annual Project ice-road season is expected to be 90 days (January 25 through April 25). Typical ice roads would be approximately 8 inches thick with a 35-foot-wide surface; typical ice roads for gravel hauling would be 70 feet wide at the surface. All ice road routes in the EIS are estimated; final alignments would be determined through optimization and impact minimization prior to construction.

Sealift modules would be transported by ice road from Atigaru Point or Point Lonely via ice road (combination of sea ice and over tundra) to the Project area. Module transport would include a 70-foot-wide surface ice road paralleled by a 35-foot-wide ice road for general vehicle traffic.

During drilling and operations, seasonal ground access from Deadhorse and Kuparuk to the Project area would be provided via the annually constructed Alpine Resupply Ice Road. Under Alternatives C and D, additional ice roads would be constructed annually to connect BT1, BT2, and BT4 with the WPF (Alternative C) or to connect the Project area to GMT-2 (Alternative D).

2.5.3.2 Gravel Roads

All-season gravel roads would connect the Project drill sites to the WPF and to the existing GMT and Alpine developments (with some exceptions under Alternatives C and D). Gravel roads would be designed to maintain the existing thermal regime and would be a minimum of 5 feet thick (average 7 feet thick due to topography) and have 2:1 side slopes. Roads accessing drill sites would be 32 feet wide at the driving surface to allow for drill rig movement, the water source access road would be 24 feet wide at the surface, and airstrip lighting access roads would be 18 feet wide at the surface. Roads would include subsistence tundra access ramps (at road pullouts) every 2.5 to 3 miles with final locations based on community input.

When possible, roads would be constructed at least 500 feet from pipeline to minimize caribou disturbance and prevent excessive snowdrifts, but no more than 1,000 feet to aid in visual pipeline inspection from the road.

2.5.3.2.1 Bridges

Bridges would be designed to maintain bottom chord clearance of 4 feet above the 100-year design-flood elevation or at least 3 feet above the highest documented flood elevation, whichever is higher. Shorter, single-span bridges would be designed to avoid placement of piers in main channels. Each bridge would be designed to accommodate drill rig movement. Multi-span bridges would be constructed on steel-pile pier groups placed approximately 60 feet apart with sheet-pile abutments. Bridges would range from 40 to 500 feet in length.

2.5.3.2.2 Culverts

Culverts would be placed in roads to maintain natural surface drainage patterns; culverts at stream or swale crossings would be placed perpendicular to the road, where feasible. Culvert size, design, and layout would be determined based on site-specific conditions. Fish-passage culverts would be placed where required (as designated by the Alaska Department of Fish and Game [ADF&G]). Preliminary cross-drainage culvert locations would be based on aerial imagery; final culvert design, number, and locations would be determined based on field conditions noted by direct observation. The estimated spacing of cross-drainage culverts is one every 1,000 feet. Culverts would be installed per the final design prior to breakup of the first construction season, but additional culverts may be placed after breakup as site-specific needs are further assessed with regulatory agencies.

2.5.3.3 Airstrip and Associated Facilities

Year-round access to the Project area from Alpine, Kuparuk, Deadhorse, or other locations would be provided by aircraft. Aircraft would support transportation of work crews, materials, and equipment to and from the Project. Air access would be supported by a 5,600-foot-long gravel airstrip located near the WOC under all action alternatives (Alternative C would include two airstrips). Airstrip location is constrained by a number of factors to ensure the safety of aircraft taking off and landing at the airstrip, including adequate clearance around structures. The airstrip(s) would be capable of supporting Hercules C-130, DC-6, Otter, and CASA aircraft, or similar; aircraft would maintain minimum altitudes consistent with **best management practice** (BMP) F-1 (BLM 2013a). Additional airstrip facilities would include a traffic control tower, apron, runway lights, and access road. Helicopters would be used to support construction, ongoing environmental studies, ice road summer maintenance (e.g., debris cleanup, tundra repair), and some activities associated with drilling and operations.

2.5.4 Other Infrastructure and Utilities

2.5.4.1 Ice Pads

Single-season and multi-season ice pads would be used to support construction. Single-season ice pads would be used during all years of construction to house construction camps, stage construction equipment, and support construction activities. Single-season ice pads would be used during construction at the gravel mine site, at bridge crossings during gravel road and pipeline construction, at the Colville River HDD crossing, onshore near the MTI, and at other locations as needed near Project infrastructure.

Multi-season ice pads would be used on a limited basis to stage construction materials between winter construction seasons; this avoids the need to place gravel fill to support temporary activities. Multi-season ice pad construction uses compacted snow over a base layer of ice with a vapor barrier over the ice to prevent melting from rain and evaporation, and foam insulation and white tarps to insulate the pads. Multi-season ice pads would then be covered by rig mats. Once the multi-season pad is no longer needed, materials would be removed any spills or releases would be cleaned before the ice is allowed to melt.

Three 10.0-acre multi-season ice pads would be used during Project construction: near GMT-2, near the WOC (South WOC under Alternative C), and at the Tiŋmiaqsiuġvik Mine Site. These pads would allow ice road, gravel mining, and other equipment to be stored on-site over the summer, which would support earlier construction starting dates the following winter, while minimizing gravel fill.

2.5.4.2 Camps

Camps required to support Project construction include camps within the Project area at the WOC and near the MTI, as well as other existing camp space (e.g., Alpine, Kuukpik Pad, and Sharktooth Camp in Kuparuk). Housing of construction workers at the Kuukpik Hotel in Nuiqsut is also possible. Camps to support drilling would be located at each drill site. The Willow Camp would support operations and be located at the WOC pad (Alternative C would also include a camp at the North WOC).

2.5.4.3 Power Generation and Distribution

Electrical power for the Project would be generated by a 98-megawatt power plant at the WPF, equipped with natural gas-fired turbines. Power would be delivered to each drill site and the WOC(s) via power cables suspended from pipeline HSMs. Following WPF startup, the power plant would also be used to power drill rigs, except during periods when power from the WPF is unreliable.

During construction and drilling, prior to completion of the permanent power supply, portable generators would provide temporary power at various locations. The portable generators would be fueled by ultra-low-sulfur diesel. Once fuel gas is available, upon startup of the WPF, diesel-fired emergency backup generators would be installed at the WPF and Willow Camp. Portable diesel-fired emergency backup generators would be available to provide emergency power at drill sites. Permanent electric power generator sets would be fully enclosed or acoustically packaged to abate noise.

2.5.4.4 Communications

Communications infrastructure would be provided by fiber-optic cables suspended from pipeline HSMs. Communication towers would be located at the WPF, and each drill site and would range between 60 and 200 feet tall. As practicable given equipment layout and potential for snow or ice loading, bird **nesting** diversion tactics (e.g., spikes) may be installed on towers.

2.5.4.5 Potable Water

Lakes M0015 (also called R0056) and R0064 (Figures 2.4.1, 2.4.2, and 2.4.3) would be the primary freshwater sources for domestic uses. Lake M0015 has an estimated volume of 643 million gallons (MG), and Lake R0064 has an estimated volume of 1,570 MG. Freshwater intake infrastructure would include a submerged pump (screened per ADF&G requirements) with a pump house set on piles at both lakes. The freshwater intake structure would be accessed by a water source access road and pads. A pipeline would transport freshwater to the water treatment plant located on the WOC. The freshwater pipeline would be a small-diameter, insulated, heat-traced, high-density polyethylene pipeline on VSMs parallel to the water source access road; it would connect to and share VSMs with the BT5 infield pipeline to the WOC. (Alternative C would include a second freshwater pipeline on shared VSMs connecting the South and North WOCs.)

The water would be treated in accordance with State drinking water regulations (18 AAC 80). Prior to freshwater intake system operation, potable water for camp use would be withdrawn using temporary equipment and trucked to the water plant at the construction camp. Additional freshwater withdrawals from other local permitted lakes would be needed during construction (ice roads and pads, hydrostatic pipeline testing, HDD), drilling (drilling support), and operations (dust control).

2.5.4.6 Domestic Wastewater

Sanitary wastes generated from camps would be hauled to the WOC wastewater treatment facility and would be disposed of in the Class I UIC disposal well located at the WOC. Before UIC well establishment, treated wastewater would be hauled to another approved disposal site or discharged under the Alaska Pollutant Discharge Elimination System (APDES) General Permit (AKG331000).

2.5.4.7 Solid Waste

Domestic waste (e.g., food, paper, wood, plastic) would either be incinerated on-site or at Alpine, or if non-burnable, would be recycled or transported to a landfill facility in Deadhorse (North Slope Borough [NSB] landfill), Fairbanks, or Anchorage. Hazardous and solid waste from the Project would be managed under Alaska Department of Environmental Conservation (ADEC) and U.S. Environmental Protection Agency (USEPA) regulations, as well as BLM BMPs.

2.5.4.8 Drilling Waste

Drilling wastes (e.g., drilling mud, cuttings) would be disposed of on-site through annular disposal (i.e., pumped down the well through the space between the two casing strings) and/or transported to an approved disposal well (e.g., Class I UIC disposal well at the WOC). Reserve pits would not be used by the Project. Produced water would be processed at the WPF and re-injected to the subsurface through injection wells as part of reservoir pressure maintenance. Well work waste materials would be managed according to the *Alaska Waste Disposal and Reuse Guide* (CPAI and BP n.d.). In addition to waste handling and disposal regulations, the Project would be managed under the 2013 BLM BMPs.

2.5.4.9 Fuel and Chemical Storage

Fuel and other chemicals would primarily be stored at the WPF, with additional storage at drill sites. Diesel fuel would be stored in temporary tanks on-site during construction under all action alternatives. During drilling and operations phases, the WPF would include a diesel fuel supply storage tank(s) and fueling station, as well as a tank farm to store methanol, crude oil flowback, corrosion inhibitor, scale inhibitor, emulsion breaker, and various other chemicals as required.

Drill sites would have temporary tanks to support drilling activity, including brine tanks, cuttings and mud tank, and a drill rig diesel fuel tank (built in as part of the drill rig structure). Production operations storage tanks at drill sites would include chemical storage tanks that may contain corrosion inhibitor, methanol, scale inhibitor, emulsion breaker, anti-foam, and diesel fuel. Portable oil storage tanks to support well and pad activities and maintenance may be present on an as-needed basis.

Fuel and oil storage would comply with local, state, and federal oil pollution prevention requirements, according to the Oil Discharge Prevention and Contingency Plan (ODPCP) and Spill Prevention Control and Countermeasures (SPCC) Plan. Secondary containment for fuel and oil storage tanks would be sized as appropriate to the container type and according to governing regulatory requirements (18 AAC 75 and 40 CFR 112). Fuel and chemical storage for the Project would be managed under BLM BMPs.

2.5.5 Water Use

Freshwater would be required for domestic use at Project camps and for ice road and pad construction and maintenance. Potable water estimates are based on a demand of 100 gallons per person per day. Freshwater may also be used for hydrostatic testing. Approximately 1.5 MG of water per mile is needed to construct a typical 35-foot-wide ice road (3 MG to construct a 70-foot-wide ice road). Approximately 0.25 MG of water is used to construct 1 acre of ice pad. (Note: 0.25 MG of water per acre is a high-level estimate for multi-season ice pads.) Water for ice roads and pads would be withdrawn from lakes near the construction activities as allowed by Alaska Department of Natural Resources (ADNR) water rights and temporary water use authorizations; fish habitat permits would be issued by ADF&G where necessary.

Freshwater would be used to make drilling mud and drilling water requirements are estimated to be 2 MG per well. Water for drilling may be withdrawn from lakes near drill sites using temporary pump and truck connections, as allowed by temporary water use authorizations and fish habitat permits. Anticipated water use is detailed by alternative in Appendix D.

Seawater would be required for injection to support enhanced oil recovery and for hydraulic fracturing operations. Approximately 80,000 to 150,000 barrels (3.4 to 6.3 MG) of seawater would be needed per day during drilling. Seawater would be sourced from the existing Kuparuk Seawater Treatment Plant at Oliktok Point and would be transported to the Project area from Kuparuk CPF2 via a new seawater pipeline.

2.5.6 Gravel Mine Site

The amount of gravel required for the Project varies by alternative and module delivery option (approximately 5.1 to 5.8 million cubic yards [cy]). Gravel would be obtained from a new gravel source in the Tiŋmiaqsiuġvik area, approximately 4 to 5 miles southeast of Greater Mooses Tooth 1 (GMT-1) (Figures 2.4.1, 2.4.2, and 2.4.3). The mine site footprint would overlap the Ublutuoch (Tiŋmiaqsiuġvik) River 0.5-mile setback; however, mine development is allowed in the setback areas (BLM BMP K-1, (BLM 2013a)).

2.5.6.1 Mine Site Description

Two 114.8-acre gravel mine sources (i.e., cells) within the Tiŋmiaqsiuġvik area (approximately 20 miles from BT3) are being evaluated by CPAI for the potential to supply some or all of the gravel required to construct the Project (Figure 2.5.4). Both 114.8-acre sites are described in the EIS but mine site design is ongoing; CPAI assumes a portion of both sites would be developed, but not the entire 229.6 acres of both sites. The gravel mine would be accessed seasonally via ice road. The pit would be open for three to four winter construction seasons to support construction of BT1, BT2, BT3, WPF, WOC, MTI, airstrip, and associated roads; the pit would be reopened later for two additional winter construction seasons to construct BT4 and BT5.

Mine site layout would be designed to minimize surface disturbances to the extent practicable. Overburden removal and gravel mining would proceed as material is needed. Mine site excavation would take place in three distinct phases: 1) organic material removal, 2) inorganic overburden removal, and 3) mining of suitable gravel material. Mining disturbance would occur incrementally and only in those areas necessary to meet seasonal needs. In subsequent construction seasons, initial rehabilitation to previously mined areas would be completed using overburden removed from the newly mined areas.

To support gravel mining, a 10.0-acre multi-season ice pad and approximately 144 acres of seasonal ice pads would be used for staging equipment, stockpiling organic and inorganic overburden, and providing a site perimeter. Pumping would be necessary to maintain a lowered water level in the gravel pit throughout mining operations. Inorganic overburden would be used for water diversion berms around the mine site perimeter, as needed, to prevent surface water flow into the mine, help maintain thermal stability of permafrost adjacent to the mine footprint, and safeguard the stability of mine walls. The dikes would be removed to within 1 foot of the original ground surface elevation upon mine closure.

2.5.6.2 Mine Site Rehabilitation

When the mine site is no longer needed as a gravel source, it would be rehabilitated and allowed to fill with water to provide waterfowl, shorebird, and potentially fish habitat similar to existing habitat in the area. The rehabilitated site would include deepwater habitat. The edge of the littoral shelf would be contoured irregularly to the mine floor. Overburden material would be used in finish grading of the mine to form the shallow areas. Plant cultivation treatments would be applied in accordance with a site-specific revegetation plan and would promote slope stability and enhance wildlife habitat value.

2.5.7 Erosion and Dust Control Plans

The Project would follow a Facilities Erosion Control Plan (FECP), which would outline procedures for operation, monitoring, and maintenance of various erosion control methods. The FECP would contain snow removal and dust control measures. Snow removal plans would include the use of snow-blowing equipment to minimize gravel carryover to the tundra and the placement of cleared snow in designated areas. Snow push areas would be determined annually, based on avoiding areas of **thermokarst**, proximity to waterbodies, and evaluating how the area looks based on the previous years' activities. The dust control plan would include watering gravel roads to minimize dust impacts to tundra. A Stormwater Pollution Prevention Plan (SWPPP) would describe management of surface water drainage for the Project pads.

CPAI would implement a Project dust control plan to minimize fugitive dust. The dust control plan would identify Project sources for fugitive dust, dust control methods and measures to be used for each source, monitoring and record keeping parameters, and plans to address extreme events (i.e., high-wind events). The Project dust control plan will be included for the Final EIS as an appendix.

2.5.8 Spill Prevention and Response

Facilities would be designed to mitigate spills and CPAI would implement a pipeline maintenance and inspection program and an employee spill prevention training program to further reduce the likelihood of spills. Production facility design would include provisions for secondary containment for hydrocarbon-based and hazardous materials. Spill prevention and response measures to be used during construction, drilling, and operations would be outlined in a Project ODPCP and SPCC Plan. In addition to regulations governing spill prevention and response, the Project would be managed under BLM BMPs (BLM 2013a).

2.5.8.1 Spill Prevention

CPAI would design and construct pipelines to comply with state, federal, and local regulations. Pipelines would be constructed of high-strength steel and would have wall thicknesses in compliance with or exceeding regulatory requirements. Pipeline welds would be validated using non-destructive testing during pipeline construction to ensure their integrity, and the pipelines would be hydrostatically tested prior to operation. The production fluids, water injection, seawater, and export pipelines would accommodate pigs for cleaning and corrosion inspection.

To further minimize the risk of a pipeline leak under the Colville River, the diesel and seawater pipelines would be installed inside high-strength casings. Simultaneous failure of both a pipeline and the casing is highly unlikely. If fluids leaked from the pipelines, they would be captured within the space between the outer wall of the pipelines and the inner walls of the casing, rather than reaching the subsurface river environment. To prevent external corrosion, the casing and pipeline would be protected by an abrasion-resistant coating in accordance with industry standards.

CPAI would maintain a corrosion control and inspection program that includes ultrasonic inspection, radiographic inspection, coupon monitoring, metal loss detection and geometry pigs, and forward-looking-infrared (FLIR) technology. The inspection programs are American Petroleum Institute Standard 570–based programs that focus inspection efforts on areas with the greatest spill potential.

2.5.8.2 Spill Response

The Project's ODPCP would demonstrate readily accessible inventories of fit-for-purpose oil spill response equipment and personnel at Project facilities. In addition, a state-registered primary response action contractor would provide trained personnel to manage spill response.

Threats to rivers and streams from a possible pipeline spill would be minimized by quickly intercepting, containing, and recovering spilled oil near the waterway crossing point. Spill response equipment would be pre-staged at strategic locations across the Project area for rapid deployment. During summer, pre-staged containment booms would be placed at strategic locations near selected river channels. Pre-deployed booms may also be placed within select stream channels to mitigate a spill, should one occur. During summer, spill containment equipment would likely be staged or deployed using helicopters. In the event of a spill, response measures could include watercraft use to access affected areas.

2.5.8.3 Spill Training and Inspections

CPAI provides regular training for its employees and contractors on preventing oil or hazardous material spills, in addition to other environmental and certification classes. The CPAI Incident Management Team participates in regularly scheduled training programs and conducts spill response drills in coordination with federal, state, and local agencies. Employees are encouraged to participate in the North Slope Spill Response Team (NSSRT), and as part of the NSSRT, members receive regularly scheduled spill response training to ensure the continuous availability of skilled spill responders on the North Slope.

CPAI is required to conduct visual examinations of pipelines and facility piping at least monthly during operations. CPAI would provide aerial overflights as necessary to allow both visual and FLIR inspection using aircraft or from the ground using handheld systems. FLIR technology can detect warm spots (i.e., oil) in low-light conditions or when other circumstances (e.g., light fog, drifted snow) limit visibility. CPAI would also conduct regular visual inspections of facilities and pipelines from gravel and ice roads, and from aircraft for sections of pipelines not paralleled by gravel roads (Alternatives C and D).

2.5.9 Abandonment and Reclamation

The abandonment and reclamation of Project facilities would be determined at or before the time of abandonment. The abandonment and reclamation plan would be subject to input from federal, state, and local authorities and private landowners. Abandonment and reclamation may involve removal of gravel pads and roads or leaving these in place for use by a different entity. Revegetation of abandoned facilities could be accomplished by seeding with native vegetation or through natural colonization. If gravel is reclaimed, it could be used for other development projects. Reclamation standards would be determined by the BLM authorized officer at the time of reclamation.

2.5.10 Schedule and Logistics

Timing of the Project is based on several factors including permitting and other regulatory approvals, Project sanctioning, and purchase and fabrication of long-lead time components. CPAI proposes to construct the Project over approximately 7 to 9 years (depending on the alternative) beginning in the first quarter (Q1) of 2021. The WPF is anticipated to come online the fourth quarter (Q4) of 2024 (first oil) for Alternatives B and C, and in Q1 of 2026 for Alternative D. Operations would run to the end of the Project’s field life, which is estimated to be 2050 (Alternatives B and C) or 2052 (Alternative D).

2.5.10.1 Construction Phase

Gravel mining and placement would be conducted almost exclusively during winter. Prepacking snow and constructing ice roads to access the gravel mine site and gravel road and pad locations would occur in December and January, with ice roads assumed to be available for use by February 1. Gravel infrastructure associated with the initial construction (BT1, BT2, BT3, roads, WPF, WOC, and airstrip) would be mined and placed during winter for the first 3 to 4 years of construction (varies by alternative). Two additional winter seasons of gravel mining and placement would occur to construct BT4, BT5, and associated roads.

Gravel roads and pads would be built following the construction of ice roads. Gravel conditioning (turning the upper layers during summer) and re-compaction would occur later that same year. Culvert locations would be identified and installed per the final design during the first construction season prior to breakup. Bridges would be constructed during winter from ice roads and pads. Once gravel pads are completed, on-pad facilities would be constructed. Modules for the WPF and drill sites BT1, BT2, and BT3 would be delivered by barge to the MTI during summer. Modules for drill sites BT4 and BT5 would be delivered via a second sealift (year varies by alternative).

Pipelines would be installed during winter from ice roads. First, VSM locations would be surveyed and drilled, and then VSMs and HSMs would be assembled and installed using a sand slurry fill. Alternatively, VSMs may be driven into an undersized hole using a vibratory hammer (this would be determined by engineering design). The pipelines would be placed, welded, tested, and then installed on pipe saddles atop the HSMs. The Colville River HDD pipeline crossing would be completed during the 2022 winter construction season. Pipeline installation would take between 1 and 3 years per pipeline, depending on pipeline length and location.

2.5.10.2 Drilling Phase

Drilling would begin in 2023 (Alternatives B and C) or 2024 (Alternative D) at BT1. The drill rig would be mobilized to the Project area and drilling would begin prior to completion of the WPF and drill site facilities. The approximately 18 to 24 months of “pre-drilling” activities would allow the WPF to be commissioned immediately following its construction. It is assumed wells would be drilled consecutively from BT1 to BT3 to BT2; however, the timing and order of drilling is based upon economics and drill rig availability. A second drill rig may be used during the drilling phase. Drilling is anticipated to take 10 to 11 years and would be conducted year-round with approximately 20 to 30 days of drilling per well.

2.5.10.2.1 Hydraulic Fracturing

Hydraulic fracturing is a process used to increase the flow of fluids from a reservoir. Each production well would receive a multistage hydraulic fracturing operation similar to those employed at other North Slope developments. The process involves isolating well sections and pumping gelled seawater or brine mixed with a proppant (small beads of sand or human-made ceramic material) at high pressure into the formation. The high-pressure fluid would create fractures in the formation, and the proppants would prevent the fracture from closing, allowing oil and gas within the formation to flow into the wellbore and ultimately the surface. It is anticipated each well would be hydraulically fractured one time with approximately 12 to 20 individual fracturing locations within the well. Hydraulic fracturing operations would last approximately 6 days per well with 6 wells per pad per year being fracture stimulated. Two hydraulic fracturing operations could occur concurrently though not on the same pad; however, fracturing operations may occur simultaneously with well drilling on the same pad. Total water use for hydraulic fracturing would be approximately 14,000 to 24,000 barrels (0.6 to 1.0 MG) of seawater.

2.5.10.3 Operations Phase

Following initial drilling and WPF startup, typical operations would consist of well operations and production. For Alternatives B and C, production would begin in Q4 of 2024 and for Alternative D, production would be delayed a minimum of 1 year and begin in Q1 of 2026. Well maintenance operations would occur intermittently throughout the life of the field.

2.5.11 Project Infrastructure in Special Areas

All action alternatives would include Project infrastructure in BLM-identified Special Areas, including the Colville River Special Area and TLSA. Designation of Special Areas does not provide specific restrictions on activities but does require such activities be conducted in such a way as to ensure the protection of surface values while being consistent with the Naval Petroleum Reserves Production Act for exploration and production activities (BLM 2013a).

2.6 Existing Lease Stipulations and Best Management Practices in the National Petroleum Reserve in Alaska

Activity in the NPR-A is subject to a variety of existing **lease stipulations** (LSs) and BMPs intended to reduce effects from development activity; these stipulations and BMPs are detailed in the 2013 NPR-A IAP/EIS ROD (BLM 2013a). Many of the previously identified stipulations and BMPs are readily incorporable into the Project, though some stipulations and BMPs may require exceptions or deviations due to Project constraints and would be evaluated by the BLM on a case-by-case basis (Appendix D, *Alternatives Development*). Table 2.6.1 lists LSs and BMPs from the 2013 NPR-A IAP/EIS ROD (BLM 2013a) anticipated to be applicable to the Project. Though the NPR-A IAP is currently under revision, the ROD for those revisions is anticipated after the Willow Project ROD, thus, LSs and BMPs from the 2013 ROD would apply to the Project.

Table 2.6.1. Applicable Existing Lease Stipulations and Best Management Practices

Category	Lease Stipulations and Best Management Practices
Waste handling and disposal	A-1, A-2, A-7
Fuels and hazardous materials handling and storage; spill prevention and spill response	A-3, A-4, A-5
Health and safety	A-8, A-11, A-12
Air quality	A-9, A-10
Water use	B-1, B-2
Winter overland moves	C-1, C-2, C-3, C-4
Facility design and construction	E-1, E-2, E-3, E-4, E-5, E-6, E-7, E-8, E-9, E-10, E-11, E-12, E-13, E-14, E-17, E-18, E-19
Aircraft use	F-1
Oilfield abandonment	G-1
Subsistence	H-1, H-3
Worker orientation	I-1
Biologically sensitive areas	K-1, K-2, K-6, K-7
Summer vehicle tundra access	L-1
General wildlife and habitat protection	M-1, M-2, M-3, M-4

Source: BLM 2013a

Likely deviations include LS E-2 and five BMPs: E-5, E-7, E-11, K-1, and K-2. Each identified deviation would be reviewed as the Project design engineering advances for opportunities to conform to LSs and BMPs to the extent practicable. See Table D.4.4 in Appendix D for additional details on the objective and requirements and standards for each BMP and the reason for deviation.

2.7 Sealift Module Delivery Options

A total of six sealift barges are anticipated for the Project to deliver large, prefabricated modules to the North Slope. Two module delivery options have been identified, and both would construct a gravel island (i.e., MTI) with a 5- to 10-year design life, though the MTI location varies by option. Under each option, modules would be delivered by sealift barge to the MTI during the open water season and transported to the Project area via ice roads (combination of sea ice and tundra based) the following winter.

The MTI would be constructed from gravel sourced from the Tiŋmiaqsiuġvik Mine Site and would provide an approximately 600-square-foot (8.3-acre) gravel work surface. MTI slopes would be armored with gravel bags and a 200-foot-long sheet pile dock face would facilitate barge offloading. On-site equipment and facilities to support winter construction would include an office, emergency camp, helipad, fuel storage area, 100-person camp, and an approximately 120-foot-tall communications tower. All equipment not needed for subsequent summer construction activities would be transferred to an onshore staging location. Summer construction activity would include reworking the gravel surface and placing slope protection materials. All construction equipment would be demobilized once construction activities are completed. The MTI would be inspected on an annual basis after breakup to identify and repair any consequential damage for its 5-year service life.

Prior to sealift barge arrival, the area in front of the dock face would require **screeding** (i.e., smoothing and leveling the seafloor) to prepare for barge off-loading. Modules would be stored on the MTI until the following winter and then be transported to the Project area. There would be two sealift delivery events occurring 2 years apart. The summer following the final sealift module transport, the island would be abandoned, and all facilities and **anthropogenic** materials would be removed from the MTI, including the gravel slope protection. It is expected that the island would be reshaped naturally by waves and ice into a crescent shape similar to a barrier island based on observations of previously constructed islands in the Beaufort Sea. It is anticipated the top of the island would drop below the water surface in 10 to 20 years following abandonment.

2.7.1 Option 1: Proponent's Module Transfer Island

CPAI has proposed construction of an MTI in Harrison Bay near Atigaru Point to support sealift module delivery (Figure 2.4.4). Appendix D, *Alternatives Development*, includes additional details regarding island construction, maintenance, and decommissioning; ice road and ice pad requirements; water use; anticipated traffic volumes; and schedule. Option 1 is BLM's preferred option. The identification of a preferred option does not constitute a commitment or decision; if warranted, the BLM may select a different option than the preferred option in its ROD.

2.7.2 Option 2: Point Lonely Module Transfer Island

An MTI at Point Lonely, a former U.S. Department of Defense site, to support sealift module delivery (Figure 2.4.5). Appendix D includes additional details regarding island construction, maintenance, and decommissioning; ice road and ice pad requirements; water use; anticipated traffic volumes; and schedule.

2.8 Comparison of Action Alternatives and Module Delivery Options

Table 2.8.1 and Figure 2.8.1 provide a comparison of action alternatives. Table 2.8.2 provides a comparison of module delivery options.

Table 2.8.1. Summary Comparison of Action Alternatives

Project Component	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Drill site gravel pads	Four 14.5-acre pads (58.0 acres total): BT1, BT2, BT4, and BT5 (BT3 would be colocated with the WPF)	Five 14.5-acre pads (72.5 acres total): BT1, BT2, BT3, BT4, and BT5	Four 14.5-acre pads (58.0 acres total): BT1, BT2, BT4, and BT5 (BT3 would be colocated with the WPF)
Willow processing facility gravel pad	WPF colocated with BT3; 34.1-acre pad	22.1-acre pad located near the south airstrip	WPF colocated with BT3; 59.5-acre pad
Willow Operations Center gravel pad	21.6-acre pad located near BT3/WPF and airstrip	Two WOC pads (36.2 acres total): South WOC (21.6 acres) located near south airstrip North WOC (14.6 acres) located near north airstrip	37.6-acre pad located near BT3/WPF and airstrip
Water source access gravel pads	Two water source access pads (1.3 acres total) at Lakes M0015 and R0064	Two water source access pads (1.3 acres total) at Lakes M0015 and R0064	Two water source access pads (1.3 acres total) at Lakes M0015 and R0064
Other gravel pads	Four valve pads (1.3 acres total); 2 pads at Judy (Iqalliqpik) Creek pipeline crossing and 2 pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.1 acres total) Tie-in pad near Alpine CD4N (0.2 acre) Pipeline crossing pad near GMT-2 (0.5 acre)	Four valve pads (1.7 acres total); 2 pads at Judy (Iqalliqpik) Creek pipeline crossing and 2 pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.1 acres total) Tie-in pad near Alpine CD4N (0.2 acre) Pipeline crossing pad near GMT-2 (0.5 acre)	Four valve pads (1.3 acres total): 2 pads at Judy (Iqalliqpik) Creek pipeline crossing and 2 pads at Fish (Uvlutuuq) Creek pipeline crossing Two HDD pipeline pads at Colville River crossing (1.1 acres total) Tie-in pad near Alpine CD4N (0.2 acre) Pipeline crossing pad near GMT-2 (0.5 acre)
Single-season ice pads	Used during construction at the gravel mine site, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (767.6 total acres)	Used during construction at the gravel mine site, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (903.6 total acres)	Used during construction at the gravel mine, bridge crossings, the Colville River HDD crossing, and other locations as needed in the Project area (982.6 total acres)
Multi-season ice pads	30.0 acres total 10.0-acre multi-season ice pad at GMT-2 (Q1 2021 to Q2 2024) 10.0-acre multi-season ice pad at WOC (Q1 2021 to Q2 2022) 10.0-acre multi-season ice pad at the Tiŋmiaqsiuġvik Mine Site (Q1 2021 to Q2 2022)	30.0 acres total 10.0-acre multi-season ice pad at GMT-2 (Q1 2021 to Q2 2024) 10.0-acre multi-season ice pad at the South WOC (Q1 2021 to Q2 2022) 10.0-acre multi-season ice pad at the Tiŋmiaqsiuġvik Mine Site (Q1 2021 to Q2 2022)	25.8 acres total 10.0-acre multi-season ice pad at GMT-2 (Q1 2021 to Q2 2024) 10.0-acre multis-season ice pat at WOC (Q1 2021 to Q2 2022); 4.2 acres would later be covered by gravel infrastructure 10.0-acre multi-season ice pad at the Tiŋmiaqsiuġvik Mine Site (Q1 2021 to Q2 2023)
Infield pipelines	31.6 total segment miles: BT1 to WPF (7.3 miles) BT2 to BT1 (5.2 miles) BT4 to BT2 (9.4 miles) BT5 to WPF (7.5 miles) Water source to WOC (2.2 miles)	56.1 total segment miles: BT1 to WPF (5.9 miles) BT2 to BT1 (5.2 miles) BT3 to WPF (5.7 miles) BT4 to BT2 (9.4 miles) BT5 to WPF (10.8 miles) Water source to South WOC (7.5 miles)	31.0 total segment miles: BT1 to WPF (7.2 miles) BT2 to BT1 (5.2 miles) BT4 to BT2 (9.4 miles) BT5 to WPF (7.0 miles) Water source to WOC (2.2 miles)

Project Component	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
		Water source (South WOC) to North WOC (11.6 miles)	
Willow export pipeline	36.5 total miles on new VSMs (WPF to tie-in pad near Alpine CD4N)	31.2 total miles on new VSMs (WPF to tie-in pad near Alpine CD4N)	36.4 total miles on new VSMs (WPF to tie-in pad near Alpine CD4N); 9.7 miles of pipeline not paralleled by gravel road
Other pipelines	67.1-mile seawater pipeline from Kuparuk CPF2 to WPF on new VSMs 34.0-mile diesel pipeline from Kuparuk CPF2 to Alpine CD4N on new VSMs and CD4N to the Alpine processing facility at Alpine CD1 on existing VSMs (3.1 miles)	61.7-mile seawater pipeline from Kuparuk CPF2 to WPF on new VSMs 68.9-mile diesel pipeline from Kuparuk CPF2 to Alpine processing facility at Alpine CD1 to South WOC on existing VSMs (6.8 miles) and new VSMs (62.1 miles); 11.6 miles to North WOC on new VSMs	66.9-mile seawater pipeline from Kuparuk CPF2 to WPF; on new VSMs 72.8-mile diesel pipeline from Kuparuk CPF2 to Alpine processing facility at Alpine CD1 to WOC on existing VSMs (6.8 miles) and new VSMs (66.0 miles)
Gravel roads	38.2 miles (285.3 total acres, including turnouts) total connecting drill sites to the WPF, WPF to GMT-2, water source access to WOC, and airstrip access and lighting access roads Eight turnouts with subsistence/tundra access ramps (3.0 acres total)	36.8 miles (273.5 total acres, including turnouts) total connecting: BT5 and BT3 to the WPF, water source access to BT3, and WPF to South WOC, South WOC to GMT-2, and airstrip access and lighting access roads BT1, BT2, and BT4 to each other and the North WOC, and north airstrip access and lighting access roads Seven vehicle turnouts with subsistence/tundra access ramps (2.6 acres total)	28.3 miles (211.9 total acres, including turnouts) total connecting BT5 to BT3/WPF; water source access to WOC; BT1, BT2, and BT4 to WOC; and airstrip access and lighting access roads; no gravel road connection to GMT-2 Six turnouts with subsistence/tundra access ramps (2.2 acres total)
Bridges	Seven total bridges: Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, and Willow Creek 8	Six total bridges: Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, Willow Creek 8	Six total bridges: Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, Fish (Uvlutuuq) Creek, Willow Creek 4, Willow Creek 4A, and Willow Creek 8
Culverts	11 culverts or culvert batteries 202 cross-drainage culverts	10 culverts or culvert batteries 194 cross-drainage culverts	8 culverts or culvert batteries 149 cross-drainage culverts
Airstrip	5,600 × 200–foot airstrip and apron (39.3 acres); would also require airstrip access and lighting access roads	North airstrip: 5,600 × 200–foot airstrip and hangar (39.3 acres); would also require airstrip access and lighting access roads South airstrip: 5,600 × 200–foot airstrip and apron (39.3 acres); would require airstrip access and lighting access roads	5,600 × 200–foot airstrip and apron (39.3 acres); would also require airstrip access and lighting access roads
Ice roads	Approximately 372.0 total miles (2,074.7 total acres) over seven construction seasons (2021 to 2028)	Approximately 471.0 total miles (2,466.7 total acres) 393.0 miles (2,135.8 acres) over eight construction seasons (2021 to 2029) 3.9 miles (16.5 acres) of annual resupply ice road (2029 to 2050; 78.0 total miles; 330.9 total acres)	Approximately 694.5 total miles (3,442.8 total acres) 478.9 miles (2,528.1 acres) over nine construction seasons (2021to 2030) 9.8 miles (41.6 acres) of annual resupply ice road (2030 to 2052; 215.6 total miles; 914.7 total acres)
Total gravel footprint and gravel fill volume	442.7 acres using 4.7 million cubic yards of gravel	487.8 acres using 5.4 million cubic yards of gravel	410.7 acres using 5.2 million cubic yards of gravel
Gravel source	Up to 230-acre site in Tiŋmiaqsiuġvik area	Up to 230-acre site in Tiŋmiaqsiuġvik area	Up to 230-acre site in Tiŋmiaqsiuġvik area

Project Component	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Roads	Alternative D: Disconnected Access
Total freshwater use	1,874.0 million gallons over the life of the Project (30 years)	2, million gallons over the life of the Project (30 years)	2,433.8 million gallons over the life of the Project (32 years)
Ground traffic[a, b] (number of trips)	3,009,933	2,340,368	3,187,363
Fixed-wing air traffic[a, c]	35,713 total flights Willow: 34,464 Alpine: 1,249	36,183 total flights South Willow: 29,096 North Willow: 5,838 Alpine: 1,249	45,398 total flights Willow: 41,967 Alpine: 3,431
Helicopter air traffic[a]	2,478 total flights Willow: 2,337 Alpine: 141	3,025 total flights South Willow: 2,327 North Willow: 572 Alpine: 126	4,658 total flights Willow: 4,476 Alpine: 182

Note: BT1 (drill site BT1); BT2 (drill site BT2); BT3 (drill site BT3); BT4 (drill site BT4); BT 5 (drill site BT5); CPF (central processing facility); GMT-2 (Greater Mooses Tooth 2); HDD (horizontal directional drilling); Q1 (first quarter); Q2 (second quarter); VSM (vertical support members); WPF (Willow processing facility)

[a] Total traffic is for the life of the Project (Alternatives B and C, 30 years; Alternative D, 32 years) and does not including any reclamation activity. Ground-traffic trips are one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as docking and subsequent departure.

[b] Number of trips includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Construction ground traffic also includes gravel hauling (e.g., B70 or maxi dump trucks).

[c] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse); includes C-130, Twin Otter or CASA, Cessna, and DC-6 or similar aircraft.

Table 2.8.2. Summary Comparison of Module Delivery Options

Project Component	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Gravel footprint (acres)	12.8	13.0
Gravel fill volume (million cubic yards)	397,000	446,000
Screeding footprint (acres)	4.9	4.9
Ice roads	117.1 total miles (1,337.5 acres) Gravel haul: 35.7 miles on tundra; 2.4 miles on sea ice Module delivery: 74.2 total miles on tundra; 4.8 miles on sea ice over two module delivery seasons	229.7 total miles (2,592.6 acres) Gravel haul: 77.9 miles on tundra; 0.6 miles on sea ice Module delivery: 150.0 total miles on tundra; 1.2 miles on sea ice over two module delivery seasons
Multi-season ice pads	Three 10.0-acre multi-season ice: One at BT1 One near Atigaru Point One midway between Atigaru Point and BT1	Three 10.0-acre multi-season ice pads: One at BT2 Two along ice road between BT2 and Point Lonely
Sealift delivery schedule (years)	Alternative B: 2023 and 2025 Alternative C: 2023 and 2025 Alternative D: 2024 and 2026	Alternative B: 2023 and 2025 Alternative C: 2023 and 2025 Alternative D: 2024 and 2026
Module mobilization (years)	Alternative B: 2024 and 2026 Alternative C: 2024 and 2026 Alternative D: 2025 and 2027	Alternative B: 2024 and 2026 Alternative C: 2024 and 2026 Alternative D: 2025 and 2027
Total freshwater usage (million gallons)	521.2	1,004.9
Total seawater usage (million gallons)	376.0	185.0
Ground traffic[a]	2,306,087 total trips	2,846,987 total trips
Fixed-wing traffic[b]	200 total flights Willow: 150 Alpine: 50	320 total flights Willow: 230 Alpine: 90
Helicopter traffic[c]	450 total flights Willow: 330 Alpine: 120	450 total flights Willow: 330 Alpine: 120
Sealift barge traffic	6 total trips	6 total trips
Support vessel traffic[d]	224 total trips	224 total trips
Construction camps and capacity (100-person capacity)	Camp for winter ice road construction (each season) on a multi-season ice pad Camp for module offload and transport on multi-season ice pad at Atigaru Point Camp for summer construction and module receipt would be located on a barge (i.e., Floatel) at module transfer island	Camp for winter ice road construction (each season) on existing gravel pad Camp for module offload and transport at Point Lonely on existing gravel pad Camp for summer construction and module receipt at Point Lonely on existing gravel pad

Note: BT1 (drill site BT1); BT2 (drill site BT2). Traffic trips are defined as one-way; a single flight is defined as a landing and subsequent takeoff; and a single vessel trip is defined as a docking and subsequent departure.

[a] Includes buses, light commercial trucks, short-haul trucks, passenger trucks, and other miscellaneous vehicles. Ground transportation also includes gravel hauling operations (i.e., B70/maxi dump trucks) and module delivery (SPMTs).

[b] Flights outlined are additional flights required beyond projected travel to/from non-Project airports (e.g., Anchorage, Fairbanks, Deadhorse) and include flights to the Alpine and Willow airstrips. Fixed-wing aircraft includes C-130, DC-6, Twin Otter/CASA, Cessna, or similar.

[c] Includes support for ice road construction, pre-staged boom deployment, hydrology and other environmental studies, and agency inspection.

[d] Includes crew boats, tugs supporting sealift barges, and other support vessels.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction and Analysis Methods

This chapter describes the existing condition of resources and uses in the Project area and the effects of the Project on those resources and uses. The chapter was developed using the best available data for each resource, which was gathered from a variety of sources.

The main documents that are incorporated by reference or tiered to in the analysis are the NPR-A Final IAP/EIS (BLM 2012b), NPR-A IAP/EIS Record of Decision (ROD) (BLM 2013a), Alpine Satellite Development Plan EIS (BLM 2004a), GMT-1 EIS (BLM 2014b), GMT-2 EIS (BLM 2018a), Liberty Development and Production Plan EIS (BOEM 2018), and Nanushuk Project EIS (USACE 2018).

The scope of the impact analysis is commensurate with the level of detail of the actions presented in Chapter 2.0, *Alternatives*, the importance of particular resources and uses and their potential to experience significant impacts, and the availability or quality of data necessary to assess impacts. All figures referred to in the analysis are in Appendix A, *Figures*. The analysis area for each resource is described at the beginning of each resource section; this is the area in which direct, indirect, or cumulative effects to the resource could occur. Analysis areas differ by resource because the geographic extent of effects varies by resource.

Some readers may better recognize locations, and common plant and animal names by their Iñupiaq or scientific names. These are provided in Appendix E.1 (*Iñupiaq and Scientific Names*) and are not described in the resource sections.

3.1.1 Past and Present Actions

Past and present actions in each resource's analysis area are included as part of the existing conditions of the affected environment for all resources analyzed in Chapter 3.0. These actions include existing oil and gas infrastructure (e.g., gravel and ice roads, processing facilities) in the Alpine and GMT oilfields (Figure 1.4.1), which are regularly serviced by aircraft.

There are several former (decommissioned) U.S. Department of Defense sites with gravel pads, roads, or airstrips near the Beaufort Sea coast. There is no existing marine infrastructure at Atigaru Point or Point Lonely.

The community of Nuiqsut (approximately 347 people, described in Section 3.16, *Subsistence and Sociocultural Systems*) would be approximately 27 miles from BT1 and about 7 miles from the Tiŋmiaqsiuġvik mine site. The community has an airstrip, roads, power plant, and other infrastructure. Seasonal snow trails and roads occur across the North Slope for community access (NSB 2018b).

Other past and present actions in the Project area are subsistence and research (not associated with oil and gas activities), which contribute additional vehicle, boat, air, foot, and off-road vehicle traffic.

Reasonably foreseeable future actions in the Project area are described in Section 3.19, *Cumulative Effects*.

3.1.2 Analysis Methods

Potential impacts are described in terms of type, context, duration, and intensity. Quantitative data are used to provide additional detail where possible and appropriate and the geographic extent of impacts is described.

The environmental analysis considers existing LSs and BMPs described in the 2013 NPR-A IAP/EIS ROD (BLM 2013a). These requirements would apply to the Project regardless of potential future revisions to the NPR-A IAP/EIS (the IAP/EIS is currently being revised) and regardless of which alternative is chosen in that ROD. Existing BMPs that relate to each resource are listed in the resource sections in Chapter 3.0. Deviations to these BMPs that would be required for the Project are detailed in Appendix D, *Alternatives Development*, and also discussed in the relevant resource sections in Chapter 3.0. Additional suggested BMPs or mitigation measures to further avoid, reduce, or compensate for impacts from the Project are discussed in the relevant resource sections in Chapter 3.0 and are summarized in Table I.1.3 in Appendix I.1, *Avoidance, Minimization, and Mitigation.* The proponent's design features to avoid and minimize impacts are also detailed in Table I.1.2 of Appendix I.1.

The likelihood and types of spills that could occur from the Project are detailed in Chapter 4.0, *Spill Risk Assessment*. The effects of these potential spills on resources and uses are described in the resource sections in Chapter 3.0.

3.2 Climate and Climate Change

The analysis area for climate change is the Arctic, with a focus on the North Slope. However, climate change occurs on a global scale; hence, the spatial extent of potential impacts is global. The temporal scale for analysis may extend from decades to an indefinite period of time. This analysis examines the potential effects of the Project on climate change and the effects of climate change on the Project.

3.2.1 Affected Environment

Climate in the Project area is described in Section 3.2.3.1, *Climate and Meteorology*, page 81 of BLM (2018a) and Section 3.5.5.1, *Meteorology and Climate*, pages 3 through 84 of USACE (2018). Climate change is “a change in the state of the climate that can be identified … by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer” (IPCC 2014). Natural internal processes, such as solar cycles or volcanic eruptions, or external forcing, such as persistent anthropogenic changes in the composition of the atmosphere or land use, can lead to climate change. **Greenhouse gases** (GHGs) warm the atmosphere by absorbing infrared radiation emitted from the Earth’s surface. Major GHGs from oil and gas development include carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). GHG emissions are reported in units of **carbon dioxide equivalent** (CO_2e) to account for the varying global warming potential (GWP) of pollutants. More information on GWP is provided in Appendix E.2A, *Climate and Climate Change Technical Appendix*. GHGs are produced both naturally (e.g., volcanoes) and through anthropogenic activities (e.g., burning of fossil fuels). Anthropogenic emissions have driven atmospheric concentrations of GHGs to levels unprecedented in the last 800,000 years (IPCC 2014). **Black carbon**, a byproduct of incomplete combustion, affects climate by absorbing and scattering solar radiation and indirectly by altering cloud properties (AMAP 2015; Xu, Martin et al. 2017). When black carbon settles on top of snow or ice, it decreases the **albedo** (i.e., reflectivity) of the surface, causing increased melting and warming. In cloud droplets, black carbon decreases the cloud albedo, which heats and dissipates the clouds. There is considerable uncertainty regarding the effect of black carbon on climate as black carbon can warm or cool the atmosphere, but the net effect is believed to be one of warming at +1.1 Watts per square meter (Bond, Doherty et al. 2013).

3.2.1.1 Observed Climate Trends and Impacts in the Arctic and on the North Slope

Global warming impacts observed globally and nationally are amplified in the Arctic. Over the past 60 years, average annual air temperatures in the region have increased by 3 degrees Fahrenheit (°F), and average winter temperatures have increased 6°F (Melillo, Richmond et al. 2014). Snow cover extent in 2017 was the lowest on record for April and May in the North American Arctic (Derksen, Brown et al. 2017). Decreased extent and duration of snow cover leads to more of the sun’s energy being absorbed by the dark land surface, and warmer surfaces lead to additional reduced snow cover (Melillo, Richmond et al. 2014). Winter maximum sea ice extent in 2017 was the lowest on record (Richter-Menge, Overland et al. 2017). Summertime sea ice has been decreasing throughout the twenty-first century with a total loss of summertime sea ice expected by 2050 or earlier (Gunsch, Kirpes et al. 2017; Kolesar, Cellini et al. 2017).

Rising temperatures result in permafrost thawing, which releases CO_2 and CH_4 to the atmosphere, accelerating climate feedback effects (Markon, Trainor et al. 2012). A recent study (Voigt, Marushchak et al. 2017) suggests thawing permafrost could lead to the release of large amounts of N_2O. Warmer temperatures combined with reduced ice cover has led to greening of the tundra and increases in soil moisture and the amount of snow water available, which have led to an increased **active layer** depth and changes in herbivore activity patterns (Clement, Bengtson et al. 2013; Epstein, Bhatt et al. 2017). Measurements by the U.S. Geological Survey (USGS) climate and permafrost observing network show that near-surface permafrost has warmed by 3 to 4 degree Celsius (°C) since the 1980s and the warming is ongoing (Urban and Clow 2016). Air temperatures across the Arctic Slope have been warming by approximately 1°C per decade during summer/autumn. Active layer temperatures are warming by about 1°C (1.8°F) per decade during all seasons, and the active layer is refreezing approximately 2 to 3 weeks later in the autumn (from mid-November in 1998 to late December in 2017). The North Slope has experienced increased average temperatures, decreased sea ice and snow cover extent, an expanded growing season, and thawing permafrost. Annual average temperatures in North Slope are expected to be -11.2°F to -9.0°F by 2019, 2.3°F higher than the annual average from 1961 to 1990 (SNAP 2018). The North Slope has shown substantial increases in tundra greenness from 1982 to 2016 (Richter-Menge, Overland et al. 2017). A warming climate was responsible, in part, for a reduction in the tundra travel season from 200 days in the 1970s to less than 120 days in 2003 (NSB 2014). Long-term permafrost temperature monitoring shows a warming trend over the past 25 years, with the greatest warming near the coast. Soil temperatures increased 3°F to 5°F between 1985 and 2004 (USFWS 2015b). Permafrost observational sites had record high temperatures at 20 meters (m) (65 feet) depth in 2016 on the North Slope. As in the wider Arctic region, the snow and ice albedo feedback from black carbon is magnified on the North Slope. Black carbon on the North Slope can arise due to a variety of sources including international transport (Matsui, Kondo et al. 2011; Stohl 2006; Xu, Martin et al. 2017), shipping (Corbett, Lack et al. 2010; Lack and Corbett 2012), oil and gas exploration and production (Ault, Williams et al. 2011), and residential combustion (Stohl, Klimont et al. 2013).

3.2.1.2 Projected Climate Trends and Impacts in the Arctic and on the North Slope

The warming in Alaska is projected to continue with average annual air temperatures increasing 2°F to 4°F between 2021 and 2050 (Melillo, Richmond et al. 2014). Temperatures on the North Slope are expected to increase by 10°F to 12°F by the end of the century if global emissions continue to increase during this century. Annual precipitation in Alaska is also projected to increase, with 15% to 30% more precipitation by late this century if global GHG emissions continue to increase (Melillo, Richmond et al. 2014). However, based on historical data, precipitation may be more variable on the North Slope. Though there was a 10% increase in statewide average precipitation in Alaska between 1949 and 2005, precipitation in Utqiaġvik (Barrow) decreased 36% from 1949 to 1998 (Markon, Trainor et al. 2012). Snow cover duration in Alaska is expected to decrease due to an earlier snowmelt and later first snowfall date (Markon, Trainor et al. 2012). Correspondingly, increases to the Alaskan growing season are also projected to continue (Melillo, Richmond et al. 2014). This change will reduce water storage and increase the risk and extent of wildfires and insect outbreaks in the region. Warmer temperatures, wetland drying, and increased summer thunderstorms have increased the number of wildfires in Alaska. The annual area burned is projected to double by mid-century, releasing more carbon to the atmosphere (Melillo, Richmond et al. 2014). Warmer temperatures will lead to a deeper active layer, which would affect the plant communities (BLM 2014a). Permafrost thawing could lead to thermokarst or slumping, causing more nutrient loading and suspended sediment in lakes and rivers. Warmer temperatures may lead to an increase in the frequency of **lake-tapping** events (sudden drainage) as degrading ice wedges integrate into drainage channels at lower elevation.

3.2.1.3 Trends in U.S. and Alaska Greenhouse Gas Emissions

GHG emissions in the U.S. are tracked by the USEPA and documented in the Inventory of U.S. Greenhouse Gases and Sinks (EPA 2019b). The Willow MDP EIS reports GHG emissions for Alaska and the U.S. to provide context for Project level direct and indirect GHG emissions and support a qualitative analysis of impacts.

In 2017, 6,457 million metric tons (MMT) of CO_2e were emitted in the U.S. This was a 1.3% increase in emissions from 1990 levels, down from a 15.7% increase observed in 2007. The major economic sectors contributing to GHG emissions in the U.S. in 2017 were transportation (29%), electricity generation (28%), industry (22%), and agriculture (9%) (EPA 2019b). Emissions of CO_2 accounted for 82% of all GHG emissions in the U.S. in 2017. As the largest source of U.S. GHG emissions, CO_2 from fossil fuel combustion has accounted for approximately 77% of GHG emissions since 1990. From 1990 to 2017, CO_2 emissions from fossil fuel combustion increased by 3.7%, and in 2016, the U.S. accounted for 15% of global fossil fuel emissions (EPA 2019b). In 2015, approximately 40 MMT CO_2e were emitted in Alaska, which was a decrease of approximately 8% from 1990 levels, and an approximately 23% decrease from the peak emissions observed in 2005 (ADEC 2018b). The industrial sector, including oil and gas industries, is the major contributor to GHG emissions in Alaska. This is followed by the transportation, residential and commercial, and electrical generation sectors (ADEC 2018b). In 2015, Alaska was the 11th lowest state in the U.S. in terms of total energy-related CO_2 emissions and the 4th highest in terms of per capita emissions (USEIA 2018). GHG emissions in Alaska represent less than 0.7% of total U.S. GHG inventory for 2015, as reported by the USEPA (2019b).

The USGS has estimated GHG emissions and carbon sequestration on federal lands for the 10-year period from 2005 to 2014 (Merrill, Sleeter et al. 2018). CO_2 emissions associated with the combustion and extraction of fossil fuels from U.S. federal lands increased from 1,362 MMT CO_2e in 2005 to 1,429 MMT CO_2e in 2010 and then decreased to 1,279 MMT CO_2e in 2014. CH_4 and N_2O emissions from federal lands also decreased over the 10-year period. Less than 1% of the federal lands CO_2 and CH_4 emissions were associated with fuel produced in

Alaska. When the federal lands fossil fuel extraction and combustion emissions are combined with ecosystem emissions and sequestration estimates, the net carbon emissions from Alaska range from -14.1 MMT CO_2e to -16.8 MMT CO_2e, indicating a net carbon sequestration from Alaska federal lands.

3.2.2 Environmental Consequences: Effects of the Project on Climate Change

It is not currently possible to determine the impact of a single project on global climate change; the USEPA has not set specific thresholds for GHG emissions. Current scientific knowledge cannot associate particular actions with specific climate effects, and a single project cannot significantly impact global GHG emissions; however, all projects may contribute cumulatively to the significant impact of global climate change. See Appendix E.2B, for a description of the method used to estimate GHG emissions. The Social Cost of Carbon, a measure used to assess the economic cost of a project's or action's climate change effects, was not used in the EIS; the reasons for this are also detailed in Appendix E.2A. For this Project, black carbon emissions were not explicitly quantified, but black carbon is a component of particulate matter less than 2.5 microns in aerodynamic diameter (**$PM_{2.5}$**) and is included in $PM_{2.5}$ emissions. See Appendix E.2A for details regarding black carbon's effects on climate. Direct and indirect GHG emissions due to the Project are assessed as a proxy for understanding the potential effects of the Project on climate change. Direct GHG emissions are those generated by construction and operations of the Project, and indirect emissions are those that are generated by transport, refining, and burning of the produced and sold oil.

3.2.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.2.1 summarizes existing applicable NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate climate change impacts from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to climate change associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.2.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Climate Change

LS or BMP	Description or Objective	Requirement
BMP A-10	Reduce air quality impacts.	For applications proposing the development of a processing facility, production pads, airstrip, roads, or other potential substantial pollutant emission source, the project proponent shall submit an emissions inventory that includes quantified emissions of regulated air pollutants from all direct and indirect project sources, including greenhouse gases, to BLM for approval. BLM may require the proponent provide an emissions reduction plan that includes a detailed description of operator committed measures to reduce project related air pollutant emissions, including but not limited to greenhouse gases and fugitive dust.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Tundra activities shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Low-ground pressure-vehicles shall be selected and operated in a manner that eliminates direct impacts to tundra. Bulldozing of tundra mat and vegetation, or trails is prohibited.
BMP L-1	Protect stream banks and water quality; minimize compaction of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation.	On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off gravel pads and roads during times other than those identified in BMP C-2a.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

3.2.2.2 Alternative A: No Action

Under Alternative A (No Action), the Project would not be developed and direct and indirect GHG emissions from the Project would not occur and contribute to climate change. Current trends in global, U.S., and Alaska GHG emissions would continue, unaffected by the Project. Energy demand would continue to be satisfied by non-Project sources varying from other oil sources to renewable sources. The Bureau of Ocean and Energy Management (BOEM) report (Appendix E.2B; *Market Substitutions and Greenhouse Gas Downstream Emissions Estimates*) presents an estimate of the GHG emissions from these replacement ("displaced substitute") energy sources using the BOEM Market Simulation Model (BOEM 2019). These are representative of emissions from energy sources displaced by the Project and are described in Table 3.2.2 in the discussion on action alternatives.

The absence of the Project itself would not lead directly to emissions. Therefore, for ease of comparison to the action alternatives, GHG emissions in the No Action Alternative are assigned a baseline value of zero in this EIS, reflecting the status quo and current GHG emissions trends in the absence of the Project.

3.2.2.3 Alternative B: Proponent's Project

The direct, indirect, and total GHG emissions over the life of the Project for Alternatives B, C, and D are shown in Table 3.2.2 below. These do not include emissions due to the module delivery options; those are reported separately in Section 3.2.2.6, *Module Delivery Options*. The calculation of the direct and indirect GHG emissions are summarized in Appendix E.2A. The gross indirect GHG emissions were calculated using BOEM's Greenhouse Gas Lifecycle Model (GHG Model) (BOEM 2019; Appendix E.2B) and represent the emissions that would result from the processing and consumption of Project oil if there were no market effects considered. The emissions in CO_2e produced from energy sources displaced by the Project are also shown in Table 3.2.2 and were derived from the displaced substitutes' emission values from the Market Simulation Model (BOEM 2019). The assumptions in both BOEM models are discussed in BOEM (2019) and references cited therein. The net CO_2e change shown in Table 3.2.2 is the difference between the previous columns and reflects the net change in CO_2e under each alternative with respect to the baseline No Action Alternative.

Tables 3.2.2, 3.2.3, and 3.2.4 report GHG emissions in CO_2e based on three different sets of GWPs (see Appendix E.2A for additional information):

- 100-year time horizon GWPs from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC 2007)
- 100-year time horizon GWPs from the IPCC Fifth Assessment Report (AR5) (IPCC 2014)
- 20-year time horizon GWPs from the IPCC AR5

Emissions calculated with the IPCC AR4 GWPs are provided as these are used in the U.S. national GHG inventory (EPA 2019b). Emissions calculated with the IPCC AR5 GWPs are also provided as they reflect more recent science (IPCC 2014).

Table 3.2.2. Total Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 100-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fourth Assessment Report

Alternative	GHG Emissions Type	Gross CO_2e Resulting from Project[a]	CO_2e from Energy Sources Displaced by Project[b]	Net CO_2e Change from Baseline CO_2e[c]
B: Proponent's Project	Direct	23,793	NA	+23,793
B: Proponent's Project	Indirect	237,626	225,157	+12,469
B: Proponent's Project	**Total**	**261,419**	**225,157**	**+36,262**
C: Disconnected Infield Roads	Direct	26,130	NA	+26,130
C: Disconnected Infield Roads	Indirect	237,686	225,214	+12,472
C: Disconnected Infield Roads	**Total**	**263,816**	**225,214**	**+38,602**
D: Disconnected Access	Direct	24,874	NA	+24,874
D: Disconnected Access	Indirect	237,838	225,173	+12,665
D: Disconnected Access	**Total**	**262,712**	**225,173**	**+37,539**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 32 years for Alternative D. The GWP values used are: CO_2 = 1; CH_4 = 25; N_2O = 298.

[a] Gross CO_2e is from the Willow Master Production indirect GHG emissions modeled by BOEM (2019). Numbers may not match exactly due to rounding.

[b] CO_2e from Energy Sources Displaced by Project is from the Displaced Substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.

[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

Table 3.2.3. Total Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 100-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fifth Assessment Report

Alternative	GHG Emissions Type	Gross CO_2e Resulting from Project[a]	CO_2e from Energy Sources Displaced by Project[b]	Net CO_2e Change from Baseline CO_2e[c]
B: Proponent's Project	Direct	23,815	NA	+23,815
B: Proponent's Project	Indirect	237,602	225,165	+12,437
B: Proponent's Project	**Total**	**261,417**	**225,165**	**+36,252**
C: Disconnected Infield Roads	Direct	26,152	NA	+26,152
C: Disconnected Infield Roads	Indirect	237,661	225,221	+12,440
C: Disconnected Infield Roads	**Total**	**263,813**	**225,221**	**+38,592**
D: Disconnected Access	Direct	24,896	NA	+24,896
D: Disconnected Access	Indirect	237,813	225,180	+12,633
D: Disconnected Access	**Total**	**262,709**	**225,180**	**+37,529**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 32 years for Alternative D. The GWP values used are: CO_2 = 1; CH_4 = 28; N_2O = 265.
[a] Gross CO_2e is from the Willow Master Production indirect GHG emissions modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[b] CO_2e from Energy Sources Displaced by Project is from the Displaced Substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

Table 3.2.4. Total Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 20-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fifth Assessment Report

Alternative	GHG Emissions Type	Gross CO2e Resulting from Projecta	CO2e from Energy Sources Displaced by Projectb	Net CO2e Change from Baseline CO2ec
B: Proponent's Project	Direct	23,354	NA	+23,354
B: Proponent's Project	Indirect	238,328	226,059	+12,269
B: Proponent's Project	**Total**	**262,682**	**226,059**	**+36,623**
C: Disconnected Infield Roads	Direct	26,693	NA	+26,693
C: Disconnected Infield Roads	Indirect	238,387	226,115	+12,272
C: Disconnected Infield Roads	**Total**	**265,080**	**226,115**	**+38,965**
D: Disconnected Access	Direct	25,450	NA	+25,450
D: Disconnected Access	Indirect	238,539	226,074	+12,465
D: Disconnected Access	**Total**	**263,989**	**226,074**	**+37,915**

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas); NA (not applicable). Project duration would be 30 years for Alternatives B and C, and 32 years for Alternative D. The GWP values used are: CO_2 = 1; CH_4 = 84; N_2O = 264.
[a] Gross CO_2e is from the Willow Master Production indirect GHG emissions modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[b] CO_2e from Energy Sources Displaced by Project is from the Displaced Substitutes GHG emissions values modeled by BOEM (2019). Numbers may not match exactly due to rounding.
[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

When applying the 100-year GWPs from the IPCC AR4 (Table 3.2.2), Alternative B's annual average direct GHG emissions (793 thousand metric tons [Mt] of CO_2e per year) over the 30-year Project life are approximately 1.983% of the 2015 Alaska GHG inventory. The annual average total gross (i.e., sum of direct and gross indirect) GHG emissions of 8,714 Mt of CO_2e per year represent approximately 0.135% of the 2017 U.S. GHG inventory. When applying the 100-year GWP from the IPCC AR5 (Table 3.2.3), Alternative B's annual average direct GHG emissions (794 Mt of CO_2e per year) are approximately 1.985% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions are again 8,714 Mt of CO_2e per year, thus constituting approximately 0.135% of the U.S. GHG inventory. When applying the 20-year GWPs from the IPC AR5 (Table 3.2.4), Alternative B's annual average direct GHG emissions (812 Mt of CO_2e per year) are approximately 2.030% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,756 thousand MT of CO_2e per year represent approximately 0.136% of the 2017 U.S. GHG inventory. In all three cases, over 90% of the total gross GHG emissions are from indirect emissions.

Overall, the choice of GWPs has little impact on the total gross CO_2e emissions because the total is dominated by indirect emissions of CO_2 which always has a GWP of one. Over the life of the Project, there would be a net increase of up to 36,623 Mt of CO_2e from the No Action Alternative (Alternative A) to Alternative B, with the highest increase estimated using the 20-year GWPs from IPCC AR5. The annual average total gross GHG emissions due to the Project in Alternative B would constitute approximately 0.14% of the total U.S. GHG inventory. The GHG emissions due to Alternative B would contribute to climate change impacts as described in Section 3.2.1.2, *Projected Climate Trends and Impacts in the Arctic and on the North Slope*.

3.2.2.4 Alternative C: Disconnected Infield Roads

Tables 3.2.2, 3.2.3, and 3.2.4 provide the direct, indirect, and total GHG emissions for Alternative C.

Direct GHG emissions over the life of the Project calculated with the IPCC AR4 100-year GWPs are 0.92% higher than Alternative B due to the increased air travel and two operations center and 0.42% higher than Alternative D. The annual average direct GHG emissions (871 Mt of CO_2e per year) over the 30-year Project life are approximately 2.178% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,794 Mt of CO_2e per year constitute approximately 0.136% of the 2017 U.S. GHG inventory. When applying the 100-year GWPs from the IPCC AR5, direct GHG emissions over the life of the Project (872 Mt of CO_2e per year) represent approximately 2.180% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,794 Mt of CO_2e per year again represent approximately 0.136% of the 2017 U.S. GHG inventory. Thus, when applying either AR4 or AR5 100-year GWPs, total gross GH emissions of the Project duration for Alternative C are 0.92% higher than Alternative B and 0.42% higher than Alternative D.

When applying the 20-year GWP from the IPCC AR5, direct GHG emissions over the 30-year Project life are 9.6% higher than Alternative B and 4.9% higher than Alternative D. The annual average direct GHG emissions (890 Mt of CO_2e per year) over the Project life are approximately 2.225% of the 2015 Alaska GHG inventory. The annual average total gross GHG emissions of 8,836 Mt of CO_2e per year constitute approximately 0.137% of the 2017 U.S. GHG inventory. Total gross GHG emissions over the Project life for Alternative C calculated with 20-year AR5 GWPs are 0.91% higher than Alternative B and 0.41% higher than Alternative D.

Over the Project duration for Alternative C, there would be a net increase of up to 38,965 Mt of CO_2e from the No Action Alternative (Alternative A) to Alternative C, with the highest increase estimated with the 20-year GWPs. Regardless of the choice of GWPs, the annual average total gross GHG emissions due to the Project under Alternative C would constitute approximately 0.14% of the total U.S. GHG inventory. The GHG emissions from Alternative C would contribute to the climate change impacts described in Section 3.2.1.2, *Projected Climate Trends and Impacts in the Arctic and on the North Slope*.

3.2.2.5 Alternative D: Disconnected Access

Tables 3.2.2, 3.2.3, and 3.2.4 provide the direct, indirect, and total GHG emissions for Alternative D.

When applying the 100-year GWPs from the IPCC AR4, direct GHG CO_2e emissions over the 32-year Project life of Alternative D are 0.49% higher than Alternative B due to increased air travel. The annual average direct GHG emissions (777 Mt of CO_2e per year) over the Project duration are approximately 1,943% of the 2015 Alaska GHG inventory and the annual average total GHG emissions of 8,210 Mt of CO_2e per year constitute approximately 0.127% of the 2017 U.S. GHG inventory. The 100-year GWPs from the IPCC AR5 direct GHG CO_2e emissions over the Project life are 4.5% higher than Alternative B. The annual average direct GHG emissions (778 Mt of CO_2e per year) over the Project life are approximately 1.945% of the 2015 Alaska GHG inventory and the annual average total GHG emissions are again 8,210 Mt of CO_2e per year represent approximately 0.127% of the 2017 U.S. GHG inventory. Thus, when applying the 100-year GWPs from either AR4 or AR5, total gross GHG emissions over the Project life for Alternative D are 0.49% higher than Alternative B and 0.42% lower than Alternative C.

When applying the 20-year GWPs from the IPCC AR5, direct GHG CO_2e emissions over the Project life are 4.5% higher than Alternative B. The annual average direct GHG emissions (795 Mt of CO_2e per year) over the 32-year Project life are approximately 1.988% of the 2015 Alaska GHG inventory and the annual average total GHG emissions of 8,249 Mt of CO_2e per year constitute 0.128% of the 2017 U.S. GHG inventory. Total gross GHG emissions over the Project duration for Alternative D calculated with 20-year IPCC AR5 GWPs are 0.50% higher than Alternative B and 0.41% lower than Alternative C.

Over the 32-year life of the Project for Alternative D, there would be a net increase of up to 37,915 Mt of CO_2e from the No Action Alternative (Alternative A) to Alternative D, with the highest increase estimated using the 20-year IPCC AR5 GWPs. The annual average total gross GHG emissions due to the Project under Alternative D represent 0.13% of the total U.S. GHG inventory. The GHG emissions due to Alternative D would contribute to climate change impacts as described in Section 3.2.1.2, *Projected Climate Trends and Impacts in the Arctic and on the North Slope*.

3.2.2.6 Module Delivery Options

3.2.2.6.1 Option 1: Proponent's Module Transfer Island

Direct Project lifetime CO_2e emissions for Option 1 would be 151.57 Mt when the calculation is based on the IPCC AR4 100-year GWPs, 151.58 Mt when using the IPCC AR5 100-year GWPs, and 151.96 Mt when using the IPCC AR5 20-year GWPs. Since the MTI does not produce oil or natural gas directly but instead supports Project construction, there would be no associated indirect GHG emissions related to module delivery options.

3.2.2.6.2 Option 2: Point Lonely Module Transfer Island

Direct Project lifetime CO_2e emissions for Option 2 would be 320.68 Mt when the calculation is based on the IPC AR4 100-year GWPs, 320.70 Mt when using the IPCC AR5 100-year GWPs, and 321.51 Mt when using the IPCC AR5 20-year GWPs. The emissions from Option 2 are approximately 170 Mt of CO_2e more than Option 1 due to the considerable increase in required ground traffic equipment and mileage associated with longer ice road routes to the Point Lonely MTI location.

3.2.2.7 Oil Spills and Accidental Releases

The EIS considers the potential effects of accidental spills. Chapter 4.0, *Spill Risk Assessment,* describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. These types of spills would potentially result in CH_4 emissions from the spill itself as well as CO_2, CH_4, and N_2O emissions associated with equipment used for containment, transportation, and clean-up (including burning), and thus contributing incrementally to climate change.

3.2.3 Effects of Climate Change on the Project

Climate change could impact the Project through a variety of ways. Key changes to anticipate as a result of a changing arctic climate are permafrost thawing, shorter ice road seasons, and changes to precipitation. Permafrost thawing and uneven settlement could cause damage to infrastructure such as gravel pads, roads, and pipelines. A shorter ice road season would affect the transport of materials and personnel that depend on ice roads; consequently, the impacts due to climate would be more substantial for Alternatives C and D due to their reliance on annual ice roads to connect the Project area to existing development during winter. More precipitation could increase surface runoff, and the design of gravel surface elevations should consider more extreme precipitation events. CPAI would accommodate these considerations in the Project's design (Appendix E.2A).

3.2.4 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. CPAI's design measures are above and beyond federal or state regulations and NPR-A IAP/EIS BMPs; these would have the additional benefit of reducing GHG emissions. These measures include capturing and injecting produced gas in a closed process to enhance oil recovery and limiting flaring to pilot flares or emergency flares. No additional BMPs or mitigation measures are recommended.

3.2.5 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Project GHG emissions and their contribution to cumulative GHG levels and climate change are unavoidable and irretrievable throughout the life of the Project. Cumulative climate change impacts may be irreversible depending on what future steps are taken to address future cumulative GHG emissions worldwide. Impacts on the long-term sustainability of the area resources is dependent on those steps.

3.3 Air Quality

The near-field analysis area for air quality is the region within approximately 50 kilometers (km) (31 miles) of the Project (Figure 3.3.1) which is the distance within which the near-field model is generally considered to be applicable (40 CFR 51 Appendix W). The far-field (i.e., regional) analysis area is the region within approximately 300 km[1] (186 miles) of the Project (Figure 3.3.1), which is expected to characterize the maximum long-range impacts on air quality and air quality related values (AQRVs) and is consistent with previous EISs (BLM 2014a). The temporal scale of the analysis ranges from acute (1 hour) to life of the Project (approximately 30 years).

3.3.1 Affected Environment

Existing air quality in the analysis area is described in this section through a review of the regional climate and meteorology, existing emission sources, and monitoring data; Appendix E.3A, *Air Quality Technical Appendix*, contains additional details.

3.3.1.1 Regulatory Framework

The Clean Air Act (CAA) requires the USEPA to establish National Ambient Air Quality Standards (NAAQS) for six common pollutants referred to as criteria air pollutants (CAPs): carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM) less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) and PM less than or equal to 10 microns in aerodynamic diameter (**PM_{10}**), and sulfur dioxide (SO_2). In Alaska, the USEPA has delegated authority to ADEC for the implementation and enforcement of the Alaska Air Quality Control Regulations (18 AAC 50) through a USEPA-approved state implementation plan. The Alaska Ambient Air Quality Standards (AAAQS) were promulgated in 18 AAC 50.010 and include additional standards beyond the NAAQS. The NAAQS and AAAQS are provided in Appendix E.3 and the analysis of impacts assesses both standards. The analysis area for air quality is designated as "attainment/unclassifiable" for all CAPs. The only nonattainment area (for $PM_{2.5}$) in Alaska is in Fairbanks, over 600 km (373 miles) from the Project.

The Prevention of Significant Deterioration (PSD) provisions of the CAA protect air quality in geographic areas designated as attainment/unclassifiable by requiring that new major emission sources or existing emission sources receiving major modifications do not result in a violation of the NAAQS or exceed maximum allowable increases in air quality (PSD increments) (40 CFR 52.21). Areas that are in attainment of the NAAQS are categorized as "Class I," "Class II," or "Class III," which determines the increment of air quality deterioration allowed, with Class I areas being the most protected. The PSD program includes special protections for the Class I areas federally designated as part of the 1977 CAA amendments and Class II areas. The program requires Federal Land Managers (FLMs) to protect AQRVs, such as visibility and deposition (NPS 2011), in these areas (40 CFR 51.166). The Class II areas within 300 km (186 miles) of the Project are the Arctic National Wildlife Refuge, Gates of the Arctic National Park, and Noatak National Preserve (Figure 3.3.1). There are no Class I areas in the analysis area.

Visibility impairment, or haze, occurs when sunlight is absorbed or scattered by particles and gases (EPA 2017). Visibility impacts are assessed by comparing the source's impact in units of delta deciviews (dv). The deciview scale is nearly zero for a pristine atmosphere, and each deciview change corresponds to a small but perceptible scenic change that is observed under either clean or polluted conditions. For example, a source that exceeds 0.5 dv (5% change in light extinction) is considered to contribute to visibility impairment, while a source that exceeds 1.0 dv (10% change in light extinction) is considered to cause visibility impairment (USFS, NPS et al. 2010).

Deposition is the transfer of pollutants from the atmosphere to soil, waterbodies, and other surfaces via dry or wet processes. There are currently no federal standards for deposition. The FLMs use critical loads (cumulative deposition flux below which no harmful effects to an ecosystem are expected) and deposition analysis thresholds (below which single-source impacts are considered negligible) to assess cumulative and source-specific deposition impacts, respectively. The critical loads for the Alaska tundra ecoregion are 1.0 to 3.0 kilograms nitrogen per hectare per year (kg N/ha/year) (NPS 2018), and the nitrogen and sulfur deposition analysis thresholds for western FLM areas are 0.005 kilogram per hectare per year (kg/ha/year) (USFS, NPS et al. 2010).

The CAA also mandates that USEPA regulate 187 hazardous air pollutants (HAPs) that are known or suspected to cause serious health effects or adverse environmental effects (42 USC 7412). The USEPA established National

[1] South of the Project, the far-field modeling domain extends approximately 250 km (155 miles).

Emission Standards for Hazardous Air Pollutants to regulate specific categories of stationary sources that emit one or more HAPs (40 CFR 63).

There are other federal and state air quality regulations that may apply to the Project including but not limited to the New Source Performance Standards (40 CFR 60), Title V Operating Permit program (40 CFR 70, 71), Greenhouse Gas Mandatory Reporting Rule (40 CFR 98), and ADEC Minor Source Permitting (18 AAC 50.502–560). The specific regulatory requirements applicable to the Project would be determined during permitting.

3.3.1.2 Characterization of Climate, Meteorology, and Air Quality in the Analysis Area

Meteorological conditions such as wind speed, wind direction, temperature, and relative humidity affect air quality conditions. The Project area is classified as a northern polar climate with long and cold winters, short and cool summers, and low annual precipitation. There is generally snow cover from October to May. Average monthly temperatures and precipitation rates at the National Weather Service monitoring station in Nuiqsut are provided in Table 3.3.1. The annual wind rose in Figure 3.3.2 shows the distribution of wind direction and speed at the CPAI monitoring station in Nuiqsut from 2013 to 2017. The prevailing wind direction was from the northeast with wind speeds averaging 5 meters per second (11.2 miles per hour). Seasonal winds patterns at Nuiqsut and additional data from other meteorological monitors are provided in Appendix E.3.

Table 3.3.1. Average Temperature and Precipitation at the Nuiqsut National Weather Service Monitor

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Max Temp (°F) [a]	-7.1	-9.6	-8.4	10.0	29.6	51.1	58.2	51.6	40.1	21.8	5.1	-2.5	20
Min Temp (°F) [a]	-22.9	-23.3	-21.5	-6.0	18.2	35.4	41.6	38.7	31.5	14.2	-8.7	-15.7	6.8
Total Precip (in) [b]	0.08	0.05	0.02	0.18	0.19	0.27	0.74	0.88	0.38	0.04	0.05	0.13	2.74

Note: °F (degrees Fahrenheit); in (inch); Max (maximum); Min (minimum); Precip (precipitation); Temp (temperature)
[a] Source: National Oceanic and Atmospheric Administration National Centers for Environmental Information (https://www.ncdc.noaa.gov/cdo-web/datatools/normals); period of record is 1981 to 2010.
[b] Source: U.S. Department of Agriculture Natural Resources Conservation Service (http://agacis.rcc-acis.org/?fips=02185).

There are several existing emissions sources, both onshore and offshore, on the North Slope and adjacent waters area, resulting in air emissions that affect air quality. Overall, onshore oil and gas sources comprise the largest fraction of existing emissions for all CAPs except PM_{10} and $PM_{2.5}$, for which dust from unpaved roads comprise the largest fraction. The largest existing sources of HAPs are onshore oil and gas activity, other nonroad vehicles and equipment, on-road gasoline powered trucks, and waste incineration, combustion, and landfills (Fields Simms, Billings et al. 2014).

Air concentrations of CAPs measured at the CPAI Nuiqsut monitoring station are provided in Table 3.3.2. The monitored concentrations are all well below the NAAQS; thus, the existing air quality in the analysis area is generally good with respect to the NAAQS.

Table 3.3.2. Measured Criteria Air Pollutant Concentrations at the Nuiqsut Monitoring Station

Pollutant (units)	Averaging Period	Rank	2015	2016	2017	Avg.	NAAQS/ AAAQS	Below NAAQS/ AAAQS?
CO (ppm)	1 hour	2^{nd} highest daily max	1	1	1	1	35	Yes
CO (ppm)	8 hours	2^{nd} highest daily max	1	1	1	1	9	Yes
NO_2 (ppb)	1 hour	99^{th} percentile of daily max	23.6	18.0	27.4	23.0	100	Yes
NO_2 (ppb)	Annual	Annual average	2	1	2	2	53	Yes
SO_2 (ppb)	1 hour	99^{th} percentile of daily max	1.2	3.2	3.5	2.6	75	Yes
SO_2 (ppb)	3 hours	2^{nd} highest daily max	1.2	3.4	3.5	2.7	500	Yes
SO_2 (ppb)	24 hours	2^{nd} highest	1.1	3.1	3.4	2.5	139	Yes
SO_2 (ppb)	Annual	Average	0.1	0.8	0.9	0.6	31	Yes
PM_{10} (µg/m^3)	24 hours	2^{nd} highest	98.5	128.8	48.8	92.1	150	Yes
$PM_{2.5}$ (µg/m^3)	24 hours	98^{th} percentile	10.0	5.5	6.9	7.5	35	Yes
$PM_{2.5}$ (µg/m^3)	Annual	Average	2.8	1.3	1.6	1.9	12	Yes
O_3 (ppb)	8 hours	4^{th} highest daily max	46	43	45	44	70	Yes

Note: AAAQS (Alaska Ambient Air Quality Standards); CO (carbon monoxide); max (maximum); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen oxides); O_3 (ozone); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); ppb (parts per billion); ppm (parts per million); SO_2 (sulfur dioxide); µg/m^3 (micrograms per cubic meter).
NAAQS/AAAQS for O_3 were converted from parts per million to parts per billion, and SO_2 24-hour and annual standards were converted from micrograms per cubic meter to parts per billion.

As shown in Figure 3.3.1, AQRV monitoring site locations are located far from the Project and are beyond the Project's far-field modeling domain boundaries. The Denali monitoring station is located at the park headquarters near Healy, Alaska, which is approximately 470 miles south of the Project. The Gates of the Arctic National Park monitoring station is located on the south side of the Brooks Range in Bettles, Alaska, which is approximately 230 miles south of the Project. Poker Creek is located 24 miles from Fairbanks, Alaska, and approximately 380 miles south of the Project. Due to the large distance between the Project and available AQRV measurements, AQRV measurements are in different airsheds than the Project. As a result, the AQRV conditions and trends in proximity to the Project could differ from results reported for the Denali, Gates of the Arctic, and Poker Creek AQRV monitoring sites.

Monitored visibility at the Gates of the Arctic National Park and Denali National Park is presented in Appendix E.3A, Figures E.3.8 and E.3.9, respectively, along with the estimated visibility under natural conditions. The haze index on the haziest days shows a downward trend at both sites with the maximum value of approximately 13 to 15 dv occurring in 2009 and 2010 at Denali National Park and Gates of the Arctic National Park, respectively. The haze index on the clearest days has been slightly higher than natural conditions and is approximately 2 to 3 dv in Denali National Park since 2000 and between 3 to 4 dv in the Gates of the Arctic National Park since monitoring began in 2010.

Trends in the wet deposition fluxes of ammonium (NH_4^-), nitrate (NO_3^-), and sulfate (SO_4^{2-}) at the National Atmospheric Deposition Program's National Trends Network (National Atmospheric Deposition Program 2018) monitors in Gates of the Arctic National Park, Poker Creek, and Denali National Park are shown in Appendix E.3A, Figures E.3.10, E.3.11, and E.3.12, respectively. Most values are below 1.0 kg/ha/year with no apparent trend in most cases. However, wet deposition fluxes of NH_4^- at Poker Creek and Denali National Park, and NO_3^- at Denali National Park, have shown an upward trend in recent years. The estimated total deposition flux of nitrogen and sulfur at Denali National Park (1999 to 2017) is provided in Appendix E.3A, Figure E.3.13. The estimated total deposition flux of nitrogen at Denali National Park is well below the critical load of the analysis area (1.0 to 3.0 kg N/ha/year) in all years.

3.3.2 Environmental Consequences

3.3.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.3.3 summarizes existing LSs and BMPs that would apply to the Project and are intended to mitigate impacts to air quality from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to air quality associated with construction, drilling, and operation of oil and gas facilities.

Table 3.3.3. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Air Quality

LS or BMP	Description or Objective	Requirement
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-9	Reduce air quality impacts	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel as defined by the Alaska Department of Environmental Conservation, Division of Air Quality.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health	The BLM will assess the potential need for baseline ambient air monitoring, preparation and submission of a project emissions inventory inclusive of direct and indirect Project emissions, an emissions reduction plan, modeling analyses, and mitigation measures. Publicly available reports will be required to be provided to the North Slope Borough, local communities, and tribes.

Source: BLM 2013a
Note: BMP (best management practice); LS (lease stipulation)

3.3.2.2 Air Emissions Inventory

The emissions inventory for the Project action alternatives was calculated based on equipment types and predicted uses. Equipment and design configurations from other North Slope projects, including the GMT-2 drill site and the Alpine Processing Facility, were used as an initial basis for the Project emissions estimates and were adapted to include Project-specific design information, where available. Project development would result in air emissions from construction, drilling and completion of new wells, operation and maintenance activities, and processing, storage, and transfer of liquid and gas products. Emissions of CAPs, GHGs[2], and HAPs come from the installation of wells, the operation of engines and boilers, and the transportation of equipment and personnel to and within the Project area, mostly due to vehicle engine combustion and vehicle traffic on unpaved roads. After the wells are completed, the processing, transport, and storage of the produced oil, liquids, and natural gas would result in emissions of CAPs, greenhouse gases, and HAPs.

The total life-of-project emissions, by pollutant, under each alternative are provided in Tables 3.3.4 and 3.3.5 with the MTI emissions at Atigaru Point (Option 1) and Point Lonely (Option 2), respectively. Emissions shown are for all Project sources plus the MTI. Under both module delivery options, Alternative C has the highest total Project emissions across all three action alternatives for criteria pollutants (8% to 21% more than Alternative B and 3% to 14% more than Alternative D) other than PM_{10}. These increased emissions are primarily due to additional equipment and infrastructure requirements necessitated by the lack of a gravel road between the WPF and BT1 for this alternative. For PM_{10}, Alternative C emissions are generally comparable to Alternative B and 8% higher than Alternative D. For both module delivery options, Alternative D has slightly (2%) higher volatile organic compounds (VOCs) and total HAPs emissions than Alternative B (with Alternative C in-between) because of the extended Alternative D[3] Project schedule. Note that air quality emissions are not equivalent to air quality impacts. As described in the following sections, the air quality emissions for the action alternatives are used in modeling analyses to estimate air quality impacts. A detailed description of the methods used to calculate the criteria and HAP emissions, as well as the activity data for each Project phase under each alternative, are provided in the Appendix E.3B, *Air Quality Technical Support Document (AQTSD)* Chapter 2.

Table 3.3.4. Total Life-of-Project Criteria Air Pollutant and Hazardous Air Pollutant Emissions (tons) due to the Project by Alternative with the Proponent's Module Transfer Island (Option 1)

Alternative	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Total HAPs
A: No Action	0	0	0	0	0	0	0
B: Proponent's Project	20,834	19,227	1,394	5,975	2,383	18,399	2,139
C: Disconnected Infield Roads	25,180	22,981	1,502	5,965	2,798	18,805	2,135
D: Disconnected Access	22,053	20,174	1,454	5,524	2,462	18,826	2,179

Note: CO (carbon monoxide); HAP (hazardous air pollutants); NOx (nitrogen oxides); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); VOC (volatile organic compounds). Greenhouse gas emissions due to the Project are discussed in Section 3.2, *Climate and Climate Change*.

Table 3.3.5. Total Life-of-Project Criteria Air Pollutant and Hazardous Air Pollutant Emissions (tons) due to the Project by Alternative with the Point Lonely Module Transfer Island (Option 2)

Alternative	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Total HAPs
A: No Action	0	0	0	0	0	0	0
B: Proponent's Project	21,337	19,869	1,395	6,021	2,408	18,486	2,148
C: Disconnected Infield Roads	25,683	23,623	1,504	6,012	2,823	18,893	2,145
D: Disconnected Access	22,556	20,816	1,455	5,571	2,487	18,914	2,189

Note: CO (carbon monoxide); HAP (hazardous air pollutants); NOx (nitrogen oxides); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); SO_2 (sulfur dioxide); VOC (volatile organic compounds). Greenhouse gas emissions due to the Project are discussed in Section 3.2, *Climate and Climate Change*.

3.3.2.3 Air Quality Impact Assessment Summary

The approach for the air quality impact assessment for the Project analysis is described in Chapter 1 of the AQTSD (Appendix E.3A). The objective of the assessment was to assess current air quality conditions and estimate the potential change in future air quality conditions associated with the Project development. Air quality and AQRV impacts were assessed within the Project area, at discrete sensitive receptor locations, and at Class II areas within approximately 300 km (186 miles) of the Project. Specifically, the air quality modeling includes:

- An assessment of air quality impacts for the criteria pollutants O_3, $PM_{2.5}$, PM_{10}, NO_2, SO_2, and CO
- An assessment of HAP impacts of benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX); n-hexane; and formaldehyde[4]
- An AQRV analysis to assess changes in visibility and acidic deposition

[2] Note that greenhouse gas emissions are described and presented in Section 3.2, *Climate and Climate Change*.
[3] The emission inventory time period for Alternative D was extended 2 years longer than for Alternative B and Alternative C to account for the delayed production schedule for Alternative D.
[4] These six HAPs were selected for analysis as BTEX and n-hexane are present in the raw natural gas, condensate, and oil. Formaldehyde is formed from the combustion of small chain alkanes that predominate in natural gas.

Note that the air quality impact analyses include additional planned developments and background air quality concentrations in order to compare total air quality and AQRV conditions to applicable standards. Therefore, results presented in the following sections include a cumulative impact assessment. More information about the planned developments and analysis of the cumulative impacts is presented in Section 3.19.5, *Cumulative Impacts to Air Quality*.

3.3.2.3.1 Near-Field Air Impact Assessment Summary

The near-field air impact assessment was conducted using the USEPA regulatory air dispersion model AERMOD to assess CAPs (excluding ozone and lead) and the HAPs listed above within 50 km (31 miles) (near-field) of the Project. The AERMOD results for air concentrations from the Project were added to the background ambient air concentrations from existing emissions sources to calculate the total air quality concentrations for comparison to the applicable NAAQS and AAAQS (collectively referred to as AAQS; Table 3.3.2). AERMOD results for air concentrations from the Project at Nuiqsut were compared to PSD Class II increments (Appendix E.3B Chapter 1; see Appendix E.3A for the PSD increment thresholds). The AERMOD model results for the HAPs were compared to non-carcinogenic acute and chronic pollutant specific threshold levels (AQTSD Chapter 1; see Appendix E.3A for the threshold levels). The calculated chronic cancer risks for the analyzed HAPs were compared to a one-in-one-million threshold. The AQTSD (Appendix E.3B Chapter 3; see Appendix E.3B) includes a detailed discussion of the near-field modeling methodology and results.

A summary of the near-field air quality modeling impacts for applicable CAPs and HAPs is provided in Table 3.3.6. In general, impacts for all criteria pollutants are below NAAQS/AAAQS, PSD increments, and HAPs thresholds, with the exception that Alternative C exceeds $PM_{2.5}$ NAAQS/AAAQS near sources at the WOC (North). The Project impacts at Nuiqsut are well below NAAQS/AAAQS, PSD increments, and HAP thresholds for all action alternatives.

Table 3.3.6. Summary of Near-Field Air Quality Modeling Impacts

Alternative	Development Scenario	Criteria Air Pollutants	Hazardous Air Pollutants
Alternative A (No Action)	Not Applicable	No impacts to criteria air pollutants. Pollutant concentrations would be similar to existing background levels.	No impacts to HAPs. Pollutant concentrations would be similar to current levels.
Alternative B (Proponent's Project)	Construction	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with the model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	BT1 Pre-Drilling	Impacts would be below all ambient air quality standards. Impacts would be identical to Alternatives C and D.	HAPs impacts were not directly assessed with the model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	Developmental Drilling	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative B	Routine Operations	Impacts would be below all ambient air quality standards.	*Non-carcinogenic:* All analyzed HAPs would be below RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs as well as total cancer risk across all pollutants were modeled and results were less than a 1-in-1-million risk for all carcinogenic HAPS analyzed.
Alternative C (Disconnected Infield Roads)	Construction	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative C	BT1 Pre-Drilling	Impacts would be identical to Alternatives B and D, and below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.

Alternative	Development Scenario	Criteria Air Pollutants	Hazardous Air Pollutants
Alternative C	Developmental Drilling	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative C	Routine Operations	Impacts to 24-hour $PM_{2.5}$ were modeled and exceeded ambient air quality standards near sources at the WOC (North) but meet the standards beyond 40 meters from the operations center. Impacts to other criteria air pollutants were modeled and were below ambient air quality standards.	*Non-carcinogenic:* All analyzed HAPs would be below respective RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs as well as total cancer risk across all pollutants were modeled and results were less than a one-in-one-million risk for all carcinogenic HAPS analyzed.
Alternative D (Disconnected Access)	Construction	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	BT1 Pre-Drilling	Impacts would be identical to Alternatives B and C, and below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	Developmental Drilling	Impacts would be below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than the routine operations development scenario.
Alternative D	Routine Operations	Impacts would be below all ambient air quality standards.	*Non-carcinogenic:* All analyzed HAPs would be below respective RELs and RfCs. *Carcinogenic:* Cancer risks for individual HAPs as well as total cancer risk across all pollutants were modeled and results were than a one-in-one-million risk for all carcinogenic HAPS analyzed.
Option 1: Proponent's Module Transfer Island	Proponent's Module Transfer Island	Onshore impacts are anticipated to be lower than Option 2 and below all ambient air quality standards.	HAPs impacts were not directly assessed with a model because HAPs emissions from MTI activities would be substantially lower than routine operations under Alternatives B, C, and D.
Option 2: Point Lonely Module Transfer Island	Point Lonely Module Transfer Island	Onshore impacts would be below all ambient air quality standards and higher than Option 1.	HAPs impacts were not directly assessed with a model because HAPs emissions from these activities would be substantially lower than routine operations under Alternatives B, C, and D.

Note: BT1 (drill site BT1); HAPs (hazardous air pollutants); MTI (module transfer island); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); REL (reference exposure level); RfC (reference concentration); WOC (Willow Operations Center)

3.3.2.3.2 Regional (Far-Field) Air Impact Assessment Summary

The regional (far-field) air impact assessment was conducted using the Comprehensive Air Quality Model with Extensions (CAMx) modeling system to assess criteria pollutants (except lead), PSD increments, and AQRVs for Alternatives B and C as well as cumulative effects from current sources and reasonably foreseeable developments and include Class II areas within approximately 300 km (186 miles) of the Project. Regional air quality impacts were assessed using regional emissions and the emissions inventory developed for the Project (Appendix E.3B, Chapter 2; see Appendix E.3B). Cumulative impacts were derived from the total concentrations estimated in the Cumulative Action Alternative scenario, i.e., a CAMx simulation with all Project and regional sources included. The Project impacts were obtained from the difference between the Cumulative Action Alternative scenario and a scenario without the Project (the Cumulative No Action scenario). Additional modeling details are provided in AQTSD Chapters 4 and 5 (Appendix E.3B).

Similar regional impacts were modeled for Alternatives B and C for air quality and AQRVs, with Alternative C typically showing slightly higher impacts. Alternative D was not modeled but was qualitatively assessed instead because its emissions (and therefore impacts) would be between the other two action alternatives or lower than either of them.

Impacts due to the Project would be higher near the Project and drop off rapidly with distance from the Project. Although mainly impacting the immediate vicinity of the Project, in general, Alternative C has a larger impact across the analysis area than Alternative B. The most noticeable difference would be expected NO_2 and $PM_{2.5}$ emissions as the larger total annual nitrogen oxides (NOx) emissions for Alternative C would lead to larger impacts to both NO_2 and particulate nitrate. The modeled spatial maximum under Alternative C was higher by 0.3 parts per billion across the analysis area than Alternative B but the spatial distribution of ozone was very similar. The Class II areas are far from the Project and modeled deposition and visibility impacts due to the Project at the Class II areas were small and below applicable thresholds.

A summary of the regional air quality modeling impacts is shown in Table 3.3.7.

Table 3.3.7. Summary of Regional Air Quality Modeling Impacts

Metric	Impact
NAAQS and AAAQS	Impacts for $PM_{2.5}$ and NO_2 in the analysis area would be typically higher for Alternative C than Alternative B. Impacts for Alternative D for the criteria air pollutants other than PM_{10} are anticipated to be lower than Alternative C and higher than Alternative B because the emissions of Alternative D are typically between these two alternatives. In the case of PM_{10}, Alternative D would have the least emissions (and therefore impacts) across all alternatives. Alternatives B and C show generally similar impacts for ozone, and Alternative D is expected to be similar as well. Alternative C would have a slightly higher (0.3 parts per billion) ozone than Alternative B. All criteria air pollutants analyzed would be below the NAAQS and AAAQS for all action alternatives.
PSD Increments	All pollutants analyzed would be below the PSD increment thresholds for Alternative B and Alternative C. Impacts for Alternative D are anticipated to be higher than Alternative B but lower than Alternative C (or lower than both alternatives in the case of PM_{10}), and thus would also be lower than the PSD increment thresholds.
Deposition	Nitrogen deposition would be higher for Alternative C than Alternative B. Nitrogen deposition for Alternative D is anticipated to be lower than Alternative C and higher than Alternative B. Sulfur deposition for all action alternatives would be similar. The nitrogen and sulfur deposition from all action alternatives would be below the deposition analysis thresholds. The cumulative nitrogen deposition for all action alternatives would not exceed the range of critical load of atmospheric deposition.
Visibility	Impacts for Alternatives B and C at the Class II areas would be comparable (with Alternative C showing slightly higher impacts during the most impaired days at Gates of the Arctic National Park and the Noatak National Preserve), and the impact for Alternative D is anticipated to be similar. Impacts would be well below 0.5 delta deciview haze index threshold, so none of the action alternatives would contribute to visibility impairment.

Note: AAAQS (Alaska Ambient Air Quality Standards); NAAQS (National Ambient Air Quality Standards); NO_2 (nitrogen oxide); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); PSD (Prevention of Significant Deterioration)

3.3.2.4 Near-Field Air Quality Modeling Results

The following sections provide an overview of the near-field air quality modeling results by action alternative. Additional detail can be found in Chapter 3 (Appendix E.3B).

3.3.2.4.1 Alternative A: No Action

Under the No Action Alternative, the Project would not occur. BLM and/or other federal permitting agencies would not issue authorizations for the Project. No oil in the Project area would be produced in the near future, and no new roads, airstrips, pipelines, or other oil facilities would be constructed. Therefore, there would be no direct Project emissions under the No Action Alternative. However, existing oil and gas exploration and development, as well as air, ground, and marine traffic would continue to contribute air emissions. The No Action Alternative is used as a baseline to aid in comparison of the anticipated local impacts among the action alternatives discussed below.

3.3.2.4.2 Alternative B: Proponent's Project

Under Alternative B, the Project would consist of four development scenarios which were analyzed for near-field impacts: construction, pre-drilling activities at BT1, developmental drilling, and routine operations. The emissions that are expected to come from these activities were estimated for CAPs, VOCs, and HAPs. Tables 3.3.4 and 3.3.5 above show the total Project life emissions, including the emissions due to the MTI. As reported in AQTSD Chapter 2 (Appendix E.3B), HAP emissions from construction and drilling activities would be substantially lower than routine operations and thus only HAP impacts for routine operations were modeled.

The near-field impact analyses were based on the maximum emissions for the individual development scenarios. All CAP impacts for construction, BT1 pre-drilling, developmental drilling, and routine operation development scenarios would be below NAAQS and AAAQS. Table 3.3.8 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative B development scenario. CAP impacts at Nuiqsut would be below PSD increments. In addition, HAP emission impacts for routine operations would be below the respective reference exposure levels (RELs) and reference concentrations (RfCs). The cancer risks for modeled individual HAPs, as well as total cancer risks across all HAPs, would be less than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts from construction, BT1 pre-drilling, and developmental drilling scenarios were not directly modeled as HAP emissions from these activities are expected to be lower than the results obtained for routine operations. Maximum HAP impacts and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.9. A detailed description of the modeling results can be found in Chapter 3 of the AQTSD (Appendix E.3B).

3.3.2.4.3 Alternative C: Disconnected Infield Roads

Alternative C would have the same gravel access road between GMT-2 and the Project area as Alternative B, but it would not include a gravel road connection from the WPF to BT1, BT2, and BT4. With no gravel road between these facilities, there would be a second airstrip and WOC (North), and a seasonal ice road would be constructed to support annual resupply for these facilities. As shown in Tables 3.3.4 and 3.3.5, the direct emissions would be higher than Alternative B due to increased air travel and two WOCs. Overall, the near-field CAP impacts from Alternative C would be below the applicable NAAQS and AAAQS for the construction, BT1 pre-drilling, and developmental drilling scenarios. Table 3.3.10 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative C development scenario. Construction impacts under Alternative C would be higher or lower than Alternatives B and D, depending on the pollutant. Impacts from BT1 pre-drilling under Alternative C would be identical to Alternatives B and D because the BT1 pre-drilling is identical across all action alternatives. Developmental drilling impacts for Alternative C at BT2 and BT3 would be comparable to or lower than impacts modeled at BT2 for Alternatives B and D.

CAPs at Nuiqsut under Alternative C were modeled to below PSD increments. Routine operations for Alternative C would be below all AAQS except for 24-hour $PM_{2.5}$ impacts, which were found to exceed the NAAQS and AAAQS near sources at the North WOC. These impacts drop below the NAAQS/AAAQS beyond 40 meters (128 feet) from the North WOC. Impacts under Alternative C during routine operations would be higher than Alternatives B and D. As with Alternative B, HAP emission impacts for routine operations would be below the respective RELs and RfCs. The modeled cancer risks for individual HAPs, as well as total cancer risk across all HAPs, were less than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts from construction, BT1 pre-drilling, and developmental drilling scenarios were not directly modeled as HAP emissions from these activities are expected to be lower than those results obtained for routine operations. Maximum HAP impacts and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.11. A detailed description of the modeling results can be found in AQTSD Chapter 3 (Appendix E.3B).

Table 3.3.8. Ambient Air Quality Standards Impacts – Alternative B

Pollutant	Averaging Period	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	BT1 Pre-Drilling Activity Domain Maximum[a]	BT1 Pre-Drilling Activity Nuiqsut[a]	Developmental Drilling Activity Domain Maximum[a]	Developmental Drilling Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	1,892.1 (5%)	1,345.7 (3%)	1,953.2 (5%)	1,302.6 (3%)	2,737.2 (7%)	1,344.8 (3%)	2,737.3 (7%)	1,344.3 (3%)
CO	8 hours	1,687.1 (17%)	1,312.0 (13%)	1,674.3 (17%)	1297.8 (13%)	2,291.8 (23%)	1,307.9 (13%)	2,291.8 (23%)	1,307.2 (13%)
NO_2	1 hour	158.4 (84%)	55.3 (29%)	89.0 (47%)	24.1 (13%)	170.2 (91%)	53.5 (28%)	166.8 (89%)	49.9 (27%)
NO_2	Annual	23.6 (24%)	3.7 (4%)	11.8 (12%)	3.2 (3%)	27.2 (27%)	3.4 (3%)	26.0 (26%)	3.4 (3%)
SO_2	1 hour	10.5 (5%)	7.7 (4%)	10.0 (5%)	6.9 (4%)	26.9 (14%)	7.4 (4%)	8.4 (4%)	7.4 (4%)
SO_2	3 hours	14.5 (1%)	9.5 (1%)	12.1 (1%)	9.1 (1%)	21.3 (2%)	9.4 (1%)	21.3 (2%)	9.4 (1%)
SO_2	24 hours	10.1 (3%)	9.0 (2%)	10.5 (3%)	8.9 (2%)	16.0 (4%)	9.0 (2%)	16.0 (4%)	9.0 (2%)
SO_2	Annual	2.5 (3%)	2.4 (3%)	2.7 (3%)	2.4 (3%)	3.8 (5%)	2.4 (3%)	3.3 (4%)	2.4 (3%)
PM_{10}	24 hours	120.5 (80%)	21.7 (14%)	34.4 (23%)	20.5 (14%)	98.8 (66%)	32.8 (22%)	98.8 (66%)	32.7 (22%)
$PM_{2.5}$	24 hours	22.5 (64%)	8.6 (24%)	17.1 (49%)	8.2 (23%)	24.4 (70%)	8.5 (24%)	24.0 (69%)	8.5 (24%)
$PM_{2.5}$	Annual	5.2 (44%)	2.0 (17%)	3.0 (25%)	2.0 (16%)	5.9 (49%)	2.0 (17%)	5.4 (45%)	2.0 (17%)

Note: CO (carbon monoxide); NO_2 (nitrogen dioxide); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); SO_2 (sulfur dioxide)
[a] Total concentration (micrograms per cubic meter), % of ambient air quality standards.

Table 3.3.9. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative B

Pollutant	Max 1-hour in Analysis Area (µg/m^3)	Acute REL (µg/m^3)	Max 8-hour in Analysis Area (µg/m^3)	Sub-Chronic AEGLs (µg/m^3)	Max Annual in Analysis Area (µg/m^3)	RfC (µg/m^3)	Cancer Risk at Nuiqsut (1/(µg/m^3))
Benzene	12.9	27	8.7	29,000	0.3	30	1.98E-09
Ethylbenzene	335.4	140,000	224.3	140,000	7.7	1,000	1.47E-08
Formaldehyde	0.9	55	0.4	1,100	0.03	9.8	7.83E-10
n-hexane	822.2	10,000,000	549.7	10,000,000	19.0	700	NA
Toluene	38.1	37,000	25.5	250,000	0.9	5,000	NA
Xylene	660.4	22,000	441.6	560,000	15.3	100	NA
Total Cancer Risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1.74E-08**

Note: AEGL (acute exposure guideline level); 1/(µg/m^3) (liters per micrograms per cubic meter); max (maximum); µg/m^3 (micrograms per cubic meter); NA (not applicable); REL (reference exposure level); RfC (reference concentration)

Table 3.3.10. Ambient Air Quality Standards Impacts – Alternative C

Pollutant	Averaging Period	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	1,774.1 (4%)	1,347.3 (3%)	3,042.5 (8%)	1,318.6 (3%)
CO	8 hours	1,629.8 (16%)	1,311.6 (13%)	2,359.6 (24%)	1,302.7 (13%)
NO_2	1 hour	158.4 (84%)	54.7 (29%)	173.4 (92%)	42.4 (23%)
NO_2	Annual	25.1 (25%)	3.7 (4%)	34.1 (34%)	3.3 (3%)
SO_2	1 hour	11.3 (6%)	7.8 (4%)	22.5 (11%)	7.5 (4%)
SO_2	3 hours	14.4 (1%)	9.6 (1%)	21.9 (2%)	9.4 (1%)
SO_2	24 hours	10.7 (3%)	9.0 (2%)	15.1 (4%)	9.0 (2%)
SO_2	Annual	2.5 (3%)	2.4 (3%)	3.0 (4%)	2.4 (3%)
PM_{10}	24 hours	84.3 (56%)	11.7 (8%)	98.8 (66%)	22.0 (15%)
$PM_{2.5}$	24 hours	22.7 (65%)	8.6 (25%)	49.7 (142%)	8.4 (24%)
$PM_{2.5}$	Annual	5.7 (47%)	2.0 (17%)	9.4 (78%)	2.0 (17%)

Note: CO (carbon monoxide); NO_2 (nitrogen dioxide); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); SO_2 (sulfur dioxide)
[a] Total concentration (micrograms per cubic meter), % of ambient air quality standards.

Table 3.3.11. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative C

Pollutant	Max 1-hour in Analysis Area (µg/m^3)	Acute REL (µg/m^3)	Max 8-hour in Analysis Area (µg/m^3)	Sub-Chronic AEGLs (µg/m^3)	Max Annual in Analysis Area (µg/m^3)	RfC (µg/m^3)	Cancer Risk at Nuiqsut (1/(µg/m^3))
Benzene	12.9	27	8.7	29,000	0.3	30	2.05E-09
Ethylbenzene	335.4	140,000	224.3	140,000	7.3	1,000	1.47E-08
Formaldehyde	0.9	55	0.3	1100	0.02	9.8	8.94E-10
n-hexane	822.2	10,000,000	549.7	10,000,000	17.9	700	NA
Toluene	38.1	37,000	25.5	250,000	0.8	5,000	NA
Xylene	660.5	22,000	441.6	560,000	14.3	100	NA
Total Cancer Risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1.76E-08**

Note: AEGL (acute exposure guideline level); 1/(µg/m^3) (liters per micrograms per cubic meter); max (maximum); µg/m^3 (micrograms per cubic meter); NA (not applicable); REL (reference exposure level); RfC (reference concentration)

3.3.2.4.4 Alternative D: Disconnected Access

Under Alternative D, there would be no all-season gravel access road connection to the GMT and Alpine developments; however, it would employ the same gravel infield roads as proposed under Alternative B. With this change, the CAP emissions, other than PM_{10}, would be higher than Alternative B due to increased air travel, but lower than Alternative C. Table 3.3.12 provides a summary of the maximum cumulative CAP impacts (modeled impacts with background concentrations added) for the modeling domain and at Nuiqsut for each Alternative D development scenario. Alternative D would have lower PM_{10} emissions (i.e., impacts) than both Alternatives B and C due to the absence of the gravel access road. The near-field impacts under Alternative D would be below the ambient air quality standards for all criteria pollutants. The BT1 pre-drilling activity for Alternative D was modeled and showed near-field impacts that are expected to be lower than Alternative B. CAPs at Nuiqsut under Alternative D would be below PSD increments. As with Alternatives B and C, all analyzed HAPs for routine operations would be below their respective RELs and RfCs. The cancer risks for individual HAPs, as well as total cancer risk across all HAPs, were modeled and found to be less than a one-in-one-million risk for all carcinogenic HAPs analyzed. HAP impacts were not analyzed for construction, BT1 pre-drilling, or developmental drilling as their impacts would be less than routine operations. Maximum HAP impacts and estimated cancer risk at Nuiqsut from routine operations are shown in Table 3.3.13. A detailed description of the modeling results can be found in Chapter 3 of the AQTSD (Appendix E.3B).

Table 3.3.12. Ambient Air Quality Standards Impacts – Alternative D

Pollutant	Averaging Period	Construction Activity Domain Maximum[a]	Construction Activity Nuiqsut[a]	Developmental Drilling Activity Domain Maximum[a]	Developmental Drilling Activity Nuiqsut[a]	Routine Operations Domain Maximum[a]	Routine Operations Nuiqsut[a]
CO	1 hour	1,892.8 (5%)	1,345.7 (3%)	2,748.8 (7%)	1,344.8 (3%)	2,748.8 (7%)	1,344.3 (3%)
CO	8 hours	1,698.0 (17%)	1,312.0 (13%)	2,291.8 (23%)	1,308.0 (13%)	2,291.8 (23%)	1,307.2 (13%)
NO_2	1 hour	158.3 (84%)	56.2 (30%)	170.2 (91%)	41.1 (22%)	170.2 (91%)	49.5 (26%)
NO_2	Annual	19.0 (19%)	3.7 (4%)	27.3 (27%)	3.4 (3%)	26.0 (26%)	3.4 (3%)
SO_2	1 hour	10.4 (5%)	7.7 (4%)	28.2 (14%)	7.4 (4%)	28.2 (14%)	7.4 (4%)
SO_2	3 hours	14.5 (1%)	9.5 (1%)	21.9 (2%)	9.4 (1%)	21.9 (2%)	9.4 (1%)
SO_2	24 hours	10.1 (3%)	9.0 (2%)	16.0 (4%)	9.0 (2%)	16.0 (4%)	9.0 (2%)
SO_2	Annual	2.5 (3%)	2.4 (3%)	3.3 (4%)	2.4 (3%)	3.3 (4%)	2.4 (3%)
PM_{10}	24 hours	144.1 (96%)	41.8 (28%)	98.8 (66%)	22.8 (15%)	98.8 (66%)	42.7 (28%)
$PM_{2.5}$	24 hours	23.0 (66%)	8.6 (24%)	24.3 (69%)	8.5 (24%)	24.1 (69%)	8.5 (24%)
$PM_{2.5}$	Annual	4.7 (39%)	2.0 (17%)	6.0 (50%)	2.0 (17%)	5.5 (46%)	2.0 (17%)

Note: CO (carbon monoxide); NO_2 (nitrogen dioxide); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); SO_2 (sulfur dioxide)

[a] Total concentration (micrograms per cubic meter), % of ambient air quality standards.

Table 3.3.13. Routine Operations Activity Hazardous Air Pollutants Impacts – Alternative D

Pollutant	Max 1-hour in Analysis Area (μg/m^3)	Acute REL (μg/m^3)	Max 8-hour in Analysis Area (μg/m^3)	Sub-Chronic AEGLs (μg/m^3)	Max Annual in Analysis Area (μg/m^3)	RfC (μg/m^3)	Cancer Risk at Nuiqsut (1/(μg/m^3))
Benzene	12.9	27	8.7	29,000	0.3	30	1.98E-09
Ethylbenzene	335.4	1,400,001	224.3	140,000	7.3	1,000	1.47E-08
Formaldehyde	1.0	55	0.4	1,100	0.03	9.8	8.39E-10
n-hexane	822.2	100,000,001	549.7	10,000,000	17.9	700	NA
Toluene	38.1	37,000	25.5	250,000	0.8	5,000	NA
Xylene	660.5	22,000	441.6	560,000	14.3	100	NA
Total Cancer Risk	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1.75E-08**

Note: AEGL (acute exposure guideline level); 1/(μg/m3); (liters per micrograms per cubic meter); max (maximum); μg/m^3 (micrograms per cubic meter); NA (not applicable); REL (reference exposure level); RfC (reference concentration)

3.3.2.4.5 Module Delivery Options

Either Option 1 (Proponent’s Module Transfer Island) or Option 2 (Point Lonely Module Transfer Island) could be selected by BLM and included in the authorized module delivery method. Air emissions from Options 1 and 2 are part of the Project emissions shown in Tables 3.3.4 and 3.3.5, respectively. CAP and HAP emissions from Option 2 are roughly twice those of Option 1 (Attachment D; see Appendix E.3B). Thus, CAP impacts were modeled for Option 2 and are discussed in the Attachment D of the AQTSD (Appendix E.3B). A summary of the maximum cumulative CAP impacts for Option 2 is shown in Table 3.3.14 below. Impacts would be below all ambient air quality standards for Option 2 and would be even lower for Option 1. Modeled impacts diminish rapidly with distance from the MTI and are negligible 25 km (16 miles) away. Impacts for HAPs were not directly modeled for either module delivery option because HAP emissions (and thus impacts) from these activities would be substantially lower than the routine operations scenario in all action alternatives.

Table 3.3.14. Ambient Air Quality Standards Impacts – Option 2 Operations Activity

Pollutant	Averaging Period	Total Concentration (µg/m^3), % of AAQS
CO	1 hour	1,770.7 (4%)
CO	8 hours	1,403.5 (14%)
NO_2	1 hour	138.6 (74%)
NO_2	Annual	3.8 (4%)
SO_2	1 hour	8.4 (4%)
SO_2	3 hours	10.1 (1%)
SO_2	24 hours	9.1 (2%)
SO_2	Annual	2.4 (3%)
PM_{10}	24 hours	25.1 (17%)
$PM_{2.5}$	24 hours	9.9 (28%)
$PM_{2.5}$	Annual	2.0 (17%)

Note: AAQS (ambient air quality standards); CO (carbon monoxide); µg/m^3 (micrograms per cubic meter); NO_2 (nitrogen dioxide); PM_{10} (particulate matter less than or equal to 10 microns in aerodynamic diameter); $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter); SO_2 (sulfur dioxide)

3.3.2.5 Regional Air Modeling Results

The following sections provide an overview of the near-field (regional) modeling results by alternative. Additional detail can be found in Chapters 4 and 5 of the AQTSD (Appendix E.3B).

3.3.2.5.1 Alternative A: No Action

No Project emissions would occur under the No Action Alternative. However, existing oil and gas exploration and development, as well as air, ground, and marine traffic and other regional sources would continue to contribute air emissions. The No Action Alternative is used as a baseline to aid a comparison of the anticipated impacts among the action alternatives discussed below. Thus, there would be no additional impacts to air quality or AQRVs under the No Action Alternative because the pollutant concentrations would be similar to regional background levels.

3.3.2.5.2 Alternative B: Proponent's Project

The modeling results show the Project and cumulative regional impacts for all pollutants would be well below the NAAQS and AAAQS, with very small contributions from the Project to regional cumulative air quality concentrations, except in the immediate vicinity of the Project. A detailed assessment of each of the CAP impacts relative to the NAAQS and AAAQS is included in Chapter 5 of the AQTSD (Appendix E.3B).

The maximum Project increments for all pollutants (NO_2, PM_{10}, $PM_{2.5}$, and SO_2) throughout the modeling domain and at the three Class II areas would be well below the PSD increments (Chapter 5 of the AQTSD; Appendix E.3). Overall, the PSD increments indicate the Project impacts would be very small and unlikely to deteriorate the air quality values at the Class II areas.

The nitrogen and sulfur deposition impacts due to the Project would be below the deposition analysis thresholds (Chapter 5 of the AQTSD; Appendix E.3B). The cumulative nitrogen deposition would be below or within the critical load range at all three Class II assessment areas. Among the three Class II areas, the Noatak National Preserve Class II area was would experience the highest nitrogen deposition and sulfur deposition due to cumulative impacts.

The Project impacts on visibility, when compared to natural background conditions, indicate that the visibility impacts would be small and Alternative B would not contribute to or cause visibility impairment in the Class II areas. A detailed visibility assessment for Alternative B is included in Chapter 5 of the AQTSD (Appendix E.3B).

3.3.2.5.3 Alternative C: Disconnected Infield Roads

As with Alternative B, the Project and cumulative impacts for all pollutants would be well below the NAAQS and AAAQS, with negligible contributions from the Project to the cumulative air quality concentrations except in the immediate vicinity of the Project. A detailed assessment of each of the criteria pollutant impacts relative to the NAAQS and AAAQS is included in Chapter 5 of the AQTSD (Appendix E.3B).

The Alternative C maximum Project increments for all pollutants (NO_2, PM_{10}, $PM_{2.5}$, and SO_2) would be well below the PSD increments in the analysis area and three Class II areas (Chapter 5 of the AQTSD; Appendix E.3B). Overall, the PSD increments indicate that the Project impacts would be very small and unlikely to deteriorate the air quality values in the Class II areas.

The nitrogen and sulfur deposition for both alternatives would be below the deposition analysis thresholds (Chapter 5 of the AQTSD; Appendix E.3B). The nitrogen deposition cumulative impacts would be below or within the critical load range at all three Class II areas. Among the three Class II areas, Noatak National Preserve would experience the highest nitrogen deposition and sulfur deposition due to cumulative impacts, the same as Alternative B.

The analysis of the visibility effects from Alternative C at the Class II areas would be similar to those of Alternative B. The Project impacts on visibility when compared to natural background conditions indicate that the visibility impacts are all small and Alternative C would not contribute to or cause visibility impairment in the Class II areas. Additional details on the regional air impacts of Alternative C is provided in Chapter 5 of the AQTSD (Appendix E.3B).

3.3.2.5.4 Alternative D: Disconnected Access

Alternative D was not assessed with the regional model because its CAP emissions (and therefore regional air quality impacts) would be typically lower than Alternative C and higher than Alternative B, or lower than both Alternative B and C in the case of PM_{10}. Therefore, all CAPs would be below the NAAQS and AAAQS under Alternative D. Project impacts related to PSD increments for Alternative D are anticipated to be higher than Alternative B but lower than Alternative C, or lower than both alternatives in the case of PM_{10}. The Project impacts are anticipated to be below the PSD increment thresholds for all CAPs in all three Class II areas. Visibility impacts would be between those for Alternatives B and C and are expected to be well below 0.5-dv threshold based on the emissions, so Alternative D would not contribute to or cause visibility impairment in the Class II areas. Nitrogen deposition for Alternative D is anticipated to be lower than Alternative C and higher than Alternative B based on the emissions. Sulfur deposition for Alternative D would be similar to the other action alternatives. The Project-specific nitrogen and sulfur deposition under Alternative D would be below the deposition analysis thresholds and the cumulative nitrogen deposition would be below or within the critical loads for nitrogen deposition.

3.3.2.5.5 Module Delivery Options

The MTIs were not included in the regional modeling; the regional air impacts of the MTI in both Options 1 and 2 are anticipated to be small because the near-field modeling showed impacts that were all below the NAAQS and AAAQS within approximately 25 km (16 miles) of the MTI. Impacts to air quality and AQRVs at the Class II areas are expected to be even lower because those areas are over 200 km (124 miles) away from the module delivery option locations.

3.3.2.6 Oil Spills and Accidental Releases

Although oil spills and other accidental releases are not a planned activity, there are potential risks related to air emissions should a spill or accidental release occur. Chapter 4.0, *Spill Risk Assessment,* describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained on gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would potentially result in VOC emissions from the spill itself as well as NOx, SO_2, and PM emissions associated with equipment used for containment, transportation, and clean-up (including burning), and thus would contribute incrementally to increased air concentrations of VOCs, NO_2, SO_2, $PM_{2.5}$, PM_{10}, and HAPs.

3.3.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. CPAI's design measures would reduce CAP and HAP emissions above and beyond federal or state regulations and existing NPR-A IAP/EIS BMPs. These measures include capturing and injecting produced gas to enhance oil recovery in a closed process, limiting flaring to pilot flares or emergency flares, and using hydraulic fracturing equipment that meet non-road engine Tier 4 emissions standards. BLM is also recommending CPAI implement a fugitive dust control plan to mitigate impacts from fugitive PM emissions from the Project. This plan would require regular watering of pads and unpaved roads, enforcing speed limits on unpaved access and haul roads, and several other measures to reduce fugitive dust emissions and impacts. The fugitive dust control plan will be included as part of the Final EIS.

3.3.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Though Project air emissions would occur, with the BMPs listed in Section 3.3.2.1, *Applicable Existing Lease Stipulations and Existing Best Management Practices*, in place the Project would meet all air quality standards. Project emissions and their contribution to cumulative GHG emissions and climate change are unavoidable and irretrievable throughout the life of the Project. Cumulative climate change impacts may be irreversible depending on what future steps are taken to address future cumulative GHG emissions worldwide. Impacts on the long-term sustainability of the area resources is dependent on those steps.

3.4 Soils, Permafrost, and Gravel Resources

The analysis area for soils, permafrost, and gravel resources is the area within 328 feet (100 m) of proposed ground disturbances and ice infrastructure during construction or operations (Figure 3.4.1). This area represents the extent of potential direct and indirect affects to soils, permafrost, and gravel resources resulting from the Project. There is little existing infrastructure in the analysis area, though ice and snow infrastructure occur across the North Slope. In the Arctic, permafrost is sensitive to disturbance and thaw induced by changes to vegetation cover or soils from alteration of drainage patterns, soil pH, albedo, or changes in snow cover, all of which can decrease the thickness of permafrost for decades (Jorgenson, Ver Hoef et al. 2010). Consequently, the temporal scale for impacts to permafrost may be finite (decades) or permanent.

3.4.1 Affected Environment

The analysis area is located in the Arctic Coastal Plain (ACP) physiographic sub-province. The ACP soils are composed of poorly drained, unconsolidated sediments transected by fluvial deposits of rivers and streams flowing northward from the foothills to the south (Wahrhaftig 1965). The fine-grained, unconsolidated sediments typically consist of **eolian** (windblown) deposits and are normally frozen with a high ice content and are about 100 feet thick. Alluvial and fluvial deposits, including active braided channels, terraces, and deltaic deposits, bisect the eolian sand deposits (Jorgenson, Kanevskiy et al. 2015).

The entire analysis area is underlain by continuous permafrost to depths between 650 to 1,300 feet (USFWS 2015b). Permafrost is ground that has been frozen for two or more consecutive years and is created by freezing temperatures maintaining water in a solid state (i.e., ice) (Jorgenson, Kanevskiy et al. 2015); the active layer (the top layer of ground subject to annual thawing and freezing) is generally between 1 and 4 feet thick (USFWS 2015b). Active layer thickness can vary from year to year and depends on such factors as ambient air temperature, aspect, gradient, vegetation, drainage, snow cover, water content, and soil type. Long-term permafrost temperature monitoring shows a warming trend over the past 25 years, with the greatest warming near the coast. Soil temperatures increased 3°F to 5°F between 1985 and 2004 (USFWS 2015b).

Polygonal, patterned ground (created when ice wedges form in the upper few feet of the ground surface) is indicative of ice-rich soils and is a common surface feature in the analysis area, especially in lowlands; polygons may be less apparent in drained upland areas, where vegetation can mask these surface features (Rawlinson 1993).

Gravel resources occur in the analysis area near the Ublutuoch (Tiŋmiaqsiuġvik) River, where a new Project mine site is proposed. Gravel resources are relatively scarce in the NPR-A, especially west and north of the Colville River (BLM 2012b). The southern portion of the NPR-A contains more abundant sand and gravel resources. The source of these sediments is the Brooks Range, from which the wind and water-transported materials were originally eroded. However, as one moves north away from the Brooks Range sediment sources, the materials become finer-grained and thus less suitable for use as construction materials. Coarser-grained sediments (including gravel) are typically found along the larger rivers in the southern NPR-A (BLM 2012b). The Clover mine site is a BLM-approved 65-acre undeveloped gravel source within NPR-A (BLM 2004b), Figure 3.4.1. The only existing or previously used sand and gravel sites within the NPR-A are located around the villages.

3.4.2 Environmental Consequences

3.4.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.4.1 summarizes existing NPR-A IAP LSs and BMPs that apply to the Project and are intended to mitigate impacts to soil, permafrost, and gravel resources from development activity (BLM 2013a). The LSs and BMPs would reduce development footprint size, and impacts related to soil compaction, permafrost, soil hydrology, fugitive dust and prohibit activities, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.4.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Soils, Permafrost, and Gravel Resources

LS or BMP	Description or Objective	Requirement
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation.	Prepare and implement a comprehensive waste management plan for all phases of development.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on the environment, including wetlands and marshes, as a result of fuel, crude oil, and other liquid chemical spills.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.
LS/BMP K-1	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas.	Permanent oil and gas facilities are prohibited in the streambed and adjacent to the rivers listed, at the distances identified. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	(Deep Water Lakes) Minimize the disruption of natural flow patterns and changes to water quality; as well as the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within one-quarter mile of the ordinary high-water mark.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect soil, permafrost, and gravel resources would include those to BMPs E-5, K-1, and K-2. BMP E-5 would require a deviation because all action alternatives would place new VSMs along existing pipeline corridors due to pipe rack capacity limits, and would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip. All action alternatives include road and pipeline crossings of waterbodies (including one or more of the waterbodies protected in BMP K-1) and freshwater intake pipelines at Lakes M0015 and R0064, previously identified deepwater lakes protected by BMP K-2 (Figure 3.10.2 in Section 3.10, *Fish*). As a result, some effects to soils in these locations may be unavoidable.

3.4.2.2 Alternative A: No Action

Under the No Action Alternative, no direct or indirect impacts to soils, permafrost, or gravel resources would occur; however, exploration for resources, including gravel and hydrocarbons, would continue in the area.

3.4.2.3 Alternative B: Proponent's Project

3.4.2.3.1 Thawing and Thermokarsting

Degradation of permafrost can be affected by ice content, soil or vegetation removal, and ground disturbances, with ice-rich and thaw-unstable soils and hillsides being the most sensitive to thawing (ADNR 2018). Thawing, ice-rich, permafrost soils create thermokarst features (periglacial topography resembling karst due to selective melting of permafrost) that transform the landscape by subsidence, erosion, and changes in drainages, including channelization and ponding (USFWS 2015b). Changes in the landforms due to erosion and thermokarst, such as slumping and channelization, affect the vegetation and water characteristics of the area (USFWS 2015b).

Placement of gravel fill can cause heat transfer to underlying soils beneath pads, which could cause thermokarst development and thaw settlement. Gravel pads would be a minimum of 5 feet thick to maintain a stable thermal regime and protect underlying permafrost. The average pad thickness would be 7 feet (details provided in Appendix D). Thermosiphons would be installed in specified areas (e.g., near well house shelters and on maintenance shop or warehousing facilities that are at grade) based on North Slope industry standard best engineering practices to protect the permafrost and prevent subsidence.

Placement of gravel fill can also change surface drainage and cause permafrost thawing, subsidence, and the accumulation of water. Project pads would be sited and oriented to minimize wind-drifted snow accumulations and alleviate ponding. Gravel fill would cover soils and kill existing vegetation, altering the thermal active layer indefinitely (USACE 2018, pg. 3-54). Alternative B would fill 442.7 acres with gravel infrastructure using 4.7 million cy of gravel.

Use of gravel infrastructure by vehicles and aircraft would create dust that would settle onto surrounding vegetation and snow. This could increase soil alkalinity, decrease albedo, increase thermal conductivity, promote earlier spring thaw than in surrounding areas, and lead to ground subsidence from the melting of ice-rich sediments (Everett 1980; Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). Where road dust increases soil alkalinity, it can reduce plant vigor in acidic tundra (Walker and Everett 1987). The majority of soils in the Project area have a pH between 5.5 and 7.4 (Raynolds, Walker et al. 2006), and thus, the impacts may be less, compared with other areas of the ACP that have more acidic tundra, which is more vulnerable to dust disturbance (Auerbach, Walker et al. 1997). Road dust has the greatest impact within 35 feet of a road, because this is where a majority of the dust is deposited, but it can have impacts up to 328 feet (100 m) of a road's surface (Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). Impacts may occur at greater distances, but the intensity of the impact decreases with distance from the road. Where dust deposition leads to melting of massive ice wedges, thermokarsting can occur. The melted ice wedges typically form flooded low spots, which exacerbate and spread the melting. This leads to the melt area extending laterally from the road and may lead to melting beyond the area immediately adjacent to the road (Walker, Raynolds et al. 2014). Under Alternative B, 3,315.6 acres of **dust shadow** would be created; an additional 151.0 acres of dust shadow would occur at the Tiŋmiaqsiuġvik mine site.

During the winter, the deposition of airborne dust reduces the albedo of roadside snow, which initiates earlier melting in the spring and increases cumulative heat absorption of the active layer, creating a deeper active layer and making the permafrost more prone to thermal erosion (NRC 2003; Walker and Everett 1987).

Ice roads and pads would compact vegetation and organic soil layers, which could reduce insulating properties and increase the potential for thermokarsting (USFWS 2014; Jorgenson et al. 2010). The magnitude of impacts would depend on the type of vegetation affected, snow depth, and depth of the active layer. Properly constructed and maintained ice roads and pads built for a single season would have minimal impacts to soils and permafrost; however, when ice roads are constructed in the same footprint in consecutive years, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Use of seasonal ice infrastructure during construction would reduce the need for gravel infrastructure, which has a greater impact on soils and permafrost. Alternative B would create 2,872.3 acres of ice infrastructure during construction.

Soils and vegetation can also be compressed by off-road travel, which can cause changes and disturbance to the insulating surface vegetation layer and result in increased active layer thickness, thawing of the permafrost, and development of thermokarst structures. Thermokarsts change the surface topography by increasing water accumulation, changing surface water drainage patterns, and increasing the potential for soil erosion and sedimentation (BLM 2018a, pg. 252; Jorgenson, Ver Hoef et al. 2010). These effects could occur in the footprint of off-road travel. Details on vegetation damage from off-road travel, including duration of vegetation recovery, are in Section 3.9, *Wetlands and Vegetation*.

Pipeline VSMs could introduce heat and displace and disturb soils around the VSM. Heat from auguring VSMs would likely dissipate within 1 week, heat gain through the VSM itself would be nominal if designed appropriately. VSM installation would occur from temporary ice infrastructure; no residual or indirect impacts would be expected from the sidecasting of cuttings because they would be removed from the ice pad and would not be allowed to reach the ground surface.

Piles driven for bridge abutments would be installed from ice infrastructure would have minimal surficial disturbance and displacement of soil and permafrost outside the diameter of the pile.

Installation of culverts for stream crossings would change airflow and thermal dynamics of the soils where culverts are placed. As culverts allow for air flow below road embankments, a deeper active layer would form below the exposed culvert than where the road or pad embankment is placed. If enough thaw is introduced at the culvert crossing, settlement may occur at that location. Conversely, if the soils thaw, heaving may occur; seasonal and differential movement may cause failure of the culvert and road embankment. Alternative B would install approximately 202 cross-drainage culverts and 11 culvert batteries.

Well casings from production and injection wells would transfer heat to the surrounding soils and could change the thermal regime of the permafrost and create areas of deep thaw. Heat transfer could also occur from warm production fluids (subsurface injections of water, drilling waste, or miscible-injectant), which can create areas of deep thaw or changes in the thermal regime. Approximately 50 boreholes per drill pad are anticipated; vertical settlement of thawed soils can occur and cause instability of the pad. Effects would likely occur in a 20- to 30-foot radius around the borehole. Thaw around the boreholes could continue to widen in radius during operation of the well and would refreeze several years after operations cease (Kutasov 2006).

Gravel mining would disturb frozen soils at the mine site and change thermal conditions in the area. This can impact groundwater characteristics immediately adjacent to the excavation and change the movement of groundwater through soils. Mining activities would reduce the amount of available thawed soil as excavation encroaches on frozen materials (BLM 2018a, pg. 250). As the rate of gravel extraction slows or ends, the **taliks** and water bearing zones would be re-established as the pit fills with water to create a pond or lake, and the soils of the pit walls are exposed to surface temperatures and allowed to thaw. Seasonal mine dewatering during mining (years 1 through 3) would cause changes in the thermal regime because the ponded water in the pit would create **thaw bulbs** or taliks. The geographic and temporal extents of thaw would vary depending on the depth and size of the pond and local soil conditions.

Stockpiles of overburden material associated with gravel mining would be stored on ice pads prior to construction and returned to the excavated mine pit prior to spring breakup. No effects to soils or permafrost are expected from stockpiled material.

Mine reclamation plans would be coordinated with agencies prior to the start of construction. Upon closure, the mine site would fill with surface water (whether it is connected to nearby streams or not), which would accelerate permafrost thaw. Water impounded in a flooded pit would likely remain unfrozen indefinitely near the bottom, creating a thaw bulb around and beneath the pit, which may cause the excavation walls to slough and deposit material into the pit (BLM 2018a, pg. 250).

3.4.2.3.2 Gravel Resource Depletion

Little information is available regarding the extent of gravel resources throughout the NPR-A. Some gravel exploration has occurred in the northeastern portion of the NPR-A and known gravel sources do exist, such as the approved (but not yet permitted or developed) Clover mine site. The Project would permanently decrease gravel sources near the Ublutuoch (Tiŋmiaqsiuġvik) River.

3.4.2.4 Alternative C: Disconnected Infield Roads

Impacts to soils, permafrost, and gravel resources under Alternative C would be the same as identified under Alternative B, with the following differences: Alternative C would require 45.1 more acres of gravel fill (487.8 total acres), 700,000 more cy of gravel, 528.0 more acres of ice infrastructure (that would have a longer duration since it would occur seasonally throughout operations), 8 less cross-drainage culverts, and 1 less culvert battery. It would also have 48.2 more acres of dust shadow. The annual ice road (3.9 miles) that would be required for Alternative C could be constructed in the same footprint in consecutive years throughout the life of the Project, which would result in more compaction and thawing of soils. For these types of ice roads, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Thus, Alternative C would have incrementally more impacts to soils, permafrost, and gravel resources than Alternative B. Table E.4.1 in Appendix E.4, *Soils, Permafrost, and Gravel Resources Technical Appendix*, details the differences among action alternatives.

3.4.2.5 Alternative D: Disconnected Access

Impacts to soils, permafrost, and gravel resources under Alternative D would be the same as identified under Alternative B, with the following differences: Alternative D would require 32.0 less acres of gravel fill (410.7 total acres), 400,000 more cy of gravel, 1,578.9 more acres of ice infrastructure (that would have a longer duration because it would occur seasonally throughout operations), 53 less cross-drainage culverts, and 3 less culvert batteries. (A larger fill volume is needed for Alternative D due to topography and depth of fill. Different alternatives require different pad thicknesses to achieve a level pad surface.) It would also have 766.4 less acres of dust shadow. The annual ice road (9.8 miles) that would be required for Alternative D could be constructed in the same footprint in consecutive years throughout the life of the Project, which would result in more compaction and thawing of soils. For these types of ice roads, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Overall, Alternative D would have slightly fewer impacts to soils, permafrost, and gravel resources than Alternative B. Table E.4.1 in Appendix E.4, details the differences among action alternatives.

3.4.2.6 Module Delivery Options

Module delivery options would affect soils, permafrost, and gravel resources by constructing ice roads (compacting soils and contributing to thaw and thermokarst) and extracting gravel (changing landforms and decreasing gravel resources). Both of these effects are described above for Alternative B.

3.4.2.6.1 Option 1: Proponent's Module Transfer Island

Option 1 would require 397,000 cy of gravel fill and 1,355.3 acres of onshore ice infrastructure.

3.4.2.6.2 Option 2: Point Lonely Module Transfer Island

Option 2 would require 446,000 cy of gravel fill and 2,753.2 acres of onshore ice infrastructure.

3.4.2.7 Oil Spills and Other Accidental Releases

The EIS addresses accidental spills that could occur from the Project. Chapter 4.0, *Spill Risk Assessment,* describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste or hazardous materials (e.g., diesel, gasoline, other chemicals) during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to impact soils, permafrost, or gravel resources.

If a spill were to occur off a gravel pad or road, the likelihood and magnitude of the impact would be influenced not only by the spill's size but also by the season in which it occurs. If a spill were to occur during the winter, the contaminant may not infiltrate into the substrate and cleanup would be possible by isolating the contaminant and removing the contaminated ice and snow for proper disposal. If a spill were to occur during the summer, the contaminant may infiltrate through the active layer before encountering permafrost. In this scenario, all sediment and contaminated soil above the permafrost may need to be treated or removed and replaced with clean material, depending on the nature of the materials. In either case, the affected area would be limited to the area of the spilled contaminant and the response efforts. A spill occurring in a body of water would have a higher potential for migration and distribution of the contaminant.

Accidental releases of diesel or glycol would not likely migrate into frozen soils, but some substances that would not freeze, such as glycol, have the potential to affect the thermal properties of soils, resulting in thawing if released beyond gravel infrastructure. The greatest impacts to soil and permafrost resources from spills would be from cleanup activities, as these would likely require excavation or disturbance of soils to remove the contamination.

Seawater spills on nonfrozen soil would have effects that could potentially last many years by killing plants, which would reduce their insulating properties. These types of spills could change the chemical composition of soils and the presence of saline conditions would depress the freezing temperature and cause soils to thaw at lower temperatures, and potentially increase the likelihood of thermokarsting.

3.4.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Additional suggested mitigation measures to reduce impacts to frozen soils as related to the design of embankments and roads could include:

1. Separate native soils from Project fill using geotextiles or fabrics
2. Use thick embankments and shallow slopes
3. Monitor thermokarsting, depth of active layer, and compression of soil and vegetation in annual resupply ice road footprint, for footprints that are used consecutively each year

3.4.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Even with LSs, BMPs, and mitigation measures, some unavoidable impacts to soil would occur, but may reduce them below a level that would be irreversible or that would result in long-term decreases in soil function in the analysis area. Soil impacts would be irretrievable during the life of the project and until project closure and reclamation is completed. If reclamation of permanent infrastructure did not occur, effects would be irreversible. Unavoidable impacts to permafrost would be irreversible.

3.5 Contaminated Sites

This chapter describes contaminated sites and spill locations and provides context to understand the likelihood of encountering existing contamination during Project construction and operations. Project handling of hazardous materials and management of hazardous wastes are described in Chapter 2.0, *Alternatives*. Unintentional releases of oil, produced water, and seawater are discussed in Chapter 4.0, *Spill Risk Assessment*.

3.5.1 Affected Environment

Records of existing contaminated sites and spills within 0.5 mile of the Project were reviewed to identify the locations, characteristics, and quantities of existing contamination. The search results are summarized below and in Figure 3.5.1; results are detailed in Appendix E.5, *Contaminated Sites Technical Appendix*.

- The ADEC Contaminated Sites database (ADEC 2019a) identified 12 contaminated sites within 0.5 mile of potential project elements. All sites have been categorized as cleanup complete and are located at Point Lonely, making them only applicable to module delivery options.
- The ADEC Prevention, Preparedness, and Response database (ADEC 2019b) did not identify any documented spills within 0.5 mile of any potential project elements.
- The BLM NPR-A Legacy Well Summary Report (BLM 2013b) indicates one legacy well (West Fish Creek site) is within 0.5 mile of the ice road route for Option 1 (Proponent's Module Transfer Island). Because ice infrastructure would not be ground disturbing and because and the site is classified as low surface and subsurface risk, it is not discussed further in the EIS. (Low surface risk means that minor solid waste is present, no known contaminants are present, and there is minimal impact to visual resources; low subsurface risk means that the well penetrated oil or gas stratigraphy, but the producible oil and gas formations are isolated or diesel present within the wellbore but is contained with no risk of release.)
- The USEPA Superfund Enterprise Management System database (EPA 2019c) did not identify any superfund sites within 0.5 mile of the Project.

3.5.2 Environmental Consequences

It is very unlikely that the Project would encounter existing contamination during Project construction or operations. The only known sites or spills are at Point Lonely or along the Atigaru Point ice road route, both of which would only be used during construction and would not experience excavation.

3.5.2.1 Applicable Existing Lease Stipulations and Best Management Practices

It is unlikely the Project would encounter existing contaminated sites during construction or operations; therefore, there are no existing NPR-A IAP LSs or BMPs that would apply.

3.5.3 Additional Suggested Best Management Practices or Mitigation

No additional BMPs or mitigation measures are recommended to avoid or reduce the likelihood that the Project would encounter existing contamination.

3.5.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Since it is unlikely that the Project would encounter existing contamination sites during construction or operations, there would be no unavoidable adverse, irretrievable, and irreversible effects.

3.6 Noise

The analysis area for noise represents the maximum distance required for most noise levels generated during construction or operation to attenuate to ambient levels (Figure 3.6.1): 0.4 to 33.2 miles, depending on the activity. The analysis area also includes areas beyond 33.2 miles where there would be very short-term or instantaneous noise events (i.e., **impulsive noise** such as blasting, pile driving) that are perceptible at greater distances than the longer term, more continuous **non-impulsive noise** sources. Specifically, this larger analysis area includes the community of Nuiqsut and surrounding subsistence areas. Impulsive noises are quantified separately in the analysis because their intensity, persistence, onset, and attenuation are different than other noise events. Because air traffic can be one of the loudest non-impulsive noise events for a North Slope project, the analysis area includes the typical flight path for Willow air traffic. Because the Kuparuk area has a higher ambient noise level and existing daily air traffic, the effects analysis for Willow is focused on the area west of Mine Site F, which has a lower intensity of industrial activity and is the area where meaningful effects from noise could occur. The temporal scale for construction-related impacts is the duration of construction (7 to 9 years), after which construction equipment and activities would no longer produce noise. The temporal scale for drilling and operational impacts is the life of the project, a period of 21 years or more. Noise from industrial activities is a common concern for Nuiqsut residents that was noted during public scoping (Appendix B, *Public Engagement and Scoping Summary Report*).

This EIS section focuses on human **noise-sensitive receptors** in the analysis area. The effects of noise on fish and wildlife are discussed in Sections 3.10 through 3.13.

3.6.1 Affected Environment

The acoustic environment is a composite of all noise sources, both natural (e.g., wildlife, wind, water) and human-made (e.g., traffic, construction, oil production, aircraft, hunting). Noise has the potential to affect people in the analysis area by interfering with activities such as sleeping or conversation, or by disrupting or diminishing one's quality of life. Table 3.6.1 provides examples of typical noise levels and human responses for context of how project noise (described below) may be perceived by people.

As noted in Table 3.6.1, sound levels of 80 to 90 A-weighted decibels[5] (dBA) typically elicit annoyance. Annoyance describes a reaction to sound based on its physical nature as well as its emotional effect (Lamancusa 2000). Though subjective, annoyance is routinely used as a basis of evaluating environmental noise effects. The level of annoyance is affected by the persistence of the sound, whether it is impulsive versus steady, the frequency and magnitude of its fluctuation, and whether the receiver finds the sound to be pleasant or unpleasant. In general, annoyance increases with the persistence of the sound, its impulsivity, and more frequent and greater fluctuations.

Noise-sensitive receptors in the analysis area are the community of Nuiqsut and subsistence users. Section 3.16, *Subsistence and Sociocultural Systems,* describes **subsistence use areas**. The EIS does not analyze occupational noise exposure for oil field workers because it is regulated separately by the Occupational Safety and Health Administration.

Ambient sound levels around Nuiqsut and the lower Colville River, including the analysis area, were documented by Stinchcomb (2017) from June through August 2016 (a period of peak subsistence use) to quantify natural ambient sound and aircraft noise levels. Natural ambient sound levels ranged from 25 to 47 dBA, with a median level of 35 dBA. The median sound exposure level of aircraft ranged from 55 to 69 dBA (Stinchcomb 2017).

High winds are common in the analysis area. Wind is the primary natural noise source in Nuiqsut (BLM 2004a). The community of Nuiqsut and the Alpine and GMT oilfield developments also contribute human-made noise (daily air and ground traffic) to the ambient soundscape in the analysis area. The analysis area also contains the

[5] Airborne sound levels are quantified using A-weighted decibels, where the decibel is a unit of sound pressure referenced to 20 micropascals (μPa). A-weighting is a system for weighting measured airborne sound levels to reflect the frequencies that people hear best.

Arctic Slope Regional Corporation (ASRC) mine site, which contributes impulsive and non-impulsive noise events during winter operations.

Table 3.6.1. Typical Noise Levels with Associated Human Perception or Response

Noise Source	Noise Level (dBA)	Human Perception or Response
Air raid siren	140	Painfully loud
Thunderclap	130	Painfully loud
Jet takeoff (200 feet)	120	Maximum vocal effort
Pile driver; rock concert	110	Extremely loud
Firecrackers	100	Very loud
Heavy truck (50 feet)	90	Very annoying
Hair dryer	80	Annoying
Noisy restaurant, freeway traffic	70	Telephone use difficult
Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room; bedroom	40	Quiet
Library; soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	Extremely quiet

Source: Noise Pollution Clearinghouse 2019
Note: dBA (A-weighted decibel)

3.6.2 Environmental Consequences

Propagation of sound in air is affected by distance, ground absorption or reflection, meteorological conditions, character of the noise, intervening topography or structures, foliage, and atmospheric absorption. An overview of acoustic principles is provided in Appendix E.13, *Marine Mammals Technical Appendix*. Of these factors, distance and the presence of intervening structures or topography tend to have the greatest effect on reducing sounds far from the source. The noise level estimates presented in the EIS were calculated based on distance attenuation alone and provide a conservative estimate for the analysis. The EIS assessed the distance needed for a noise source to attenuate to the ambient level of 35 dBA, and also identified potential sound levels in Nuiqsut.

Both impulsive and non-impulsive noise were analyzed. These noises are different in their origin, intensity, persistence, onset, and decay. Impulsive noise is short-term instantaneous noise with a high intensity, short persistence, abrupt onset, and rapid decay; impulsive noise bursts may occur in rapid succession. This type of noise is typically created when one object strikes another object, such as a hammer striking a pile. Non-impulsive noise has a steady intensity and longer persistence, such as noise created by dump trucks, bulldozers, compaction rollers, and other construction equipment. Sound levels generated by impulsive noise, such as pile driving or blasting, may significantly exceed the ambient sound level for a very short duration. Non-impulsive, more continuous noise sources typically emit lower levels of noise and are less likely to be audible at a distance (described in detail below).

Multiple individual noise sources can combine to result in higher noise levels, but the combined noise is not directly additive. Combined noise sources that differ more than 10 dBA from one another are dominated by the louder source. For example, if blasting or pile driving is occurring, adding truck traffic would likely not increase noise levels noticeably from blasting or pile driving alone.

3.6.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.6.2 summarizes existing NPR-A IAP LSs and BMPs that apply to the Project and are intended to mitigate noise impacts from development activity (BLM 2013a). The LSs and BMPs would reduce adverse noise impacts to wildlife and human populations from mobile and stationary equipment, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.6.2. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts from Noise

LS or BMP	Description or Objective	Requirement
BMP C-1	Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.	Cross-country use of heavy equipment is prohibited within one-half mile of occupied grizzly bear dens, and within 1 mile of known or observed polar bear dens or seal birthing lairs.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.	Aerial surveys for species will be conducted prior to construction. The applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats, and address management of high noise levels.
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. See Appendix I.1, *Avoidance, Minimization, and Mitigation*, for specific BMP F-1 guidelines.
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat, minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters as designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses.

Source: BLM 2013a
Note: ADF&G (Alaska Department of Fish and Game); BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); USFWS (U.S. Fish and Wildlife Service)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect noise would include those to BMPs E-5 and E-11. BMP E-5 would require a deviation because all action alternatives would place new VSMs along existing pipeline corridors due to pipe rack capacity limits and would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip. All action alternatives would require a deviation from BMP E-11 due to the proximity of Stellar's eiders to the Project area.

3.6.2.2 Alternative A: No Action

Under the No Action Alternative, new construction noise in the Willow area would not occur. Existing human-made noise sources from oil and gas exploration and development, subsistence activities, and air, ground, and marine traffic would continue to affect the soundscape.

3.6.2.3 Alternative B: Proponent's Project

Noise levels and effects related to various elements of Alternative B are summarized in Table 3.6.3. General non-impulsive construction equipment would occur in various locations (near gravel and ice infrastructure) through the construction period. Blasting would be used intermittently to fracture and displace rock. Gravel mining would occur during the winter months during construction. Impact pile driving for bridge construction would produce substantial levels of impulsive noise for relatively short periods (days or weeks) at bridge locations.

Most non-impulsive noise in Table 3.6.3 would attenuate to ambient sound levels prior to reaching Nuiqsut and would not affect people in the community. Aircraft activity could potentially be audible in Nuiqsut if planes traveled within 20.3 miles of the community or helicopters traveled within 33.2 miles, but the sound levels of most aircraft activity would be less than 39 dBA, which is typically considered protective of residential uses.

Impulsive noise during construction would have farther-reaching effects, but the effects would be short-lived and instantaneous compared to other construction activities. Blasting would be very annoying near the source, and intrusive to conversation in Nuiqsut. However, these noise events would be very short-lived and instantaneous. Impact pile driving would be annoying near the source, and quiet locations (similar to a living room) in Nuiqsut.

Table 3.6.3. Summary of Potential Noise for All Project Phases

Noise Source	Project Phase: Duration	Estimated Sound 1,000 feet from the Source (dBA)	Nearest Distance from Project Action to Nuiqsut (miles)	Distance to 35 dBA[a] (miles)	Estimated Sound at Nuiqsut (dBA)	Data Source
General construction[b] (bulldozers, loaders, cranes, etc.)	Construction: Alt B 7 yrs, Alt C 8 yrs, Alt D 9 yrs	62	7.4	4.0	30	BLM 2018a
Gravel mining[b] (bulldozers, loaders, crushers, screens, etc.)	Construction: Alt B 5 yrs, Alt C, D 6 yrs	62	6.8	4.0	31	BLM 2018a
Gravel mine blasting, Lmax	Construction: Alt B 5 yrs, Alt C, D 6 yrs	90	6.8	101.9	59	Ramboll US Corporation 2017
Impact pipe pile driving, Lmax	Construction: Alt B 5 yrs, Alt C, D 4 yrs	84	24.0	50.9	42	WSDOT 2015
Helicopter (B206)	All: 30 years	70 to 80	23.4 to 27.9[c]	10.5 to 33.2	27 to 38[d]	BLM 2004a
Fixed-wing aircraft (twin-engine)	All: 30 years	69 to 81	23.4 to 27.9[c]	6.4 to 20.3	26 to 39[d]	BLM 2004a
Ground traffic	All: 30 years	49 to 55	7.4	0.9 to 1.4	17 to 23	BLM 2018a
Drill rig	All: 10 to 11 years total	52 to 66	26.3	1.3 to 6.4	9 to 23	ARCO Alaska 1986
WPF	Operations: ≥ 25 years	52	29.3	1.3	8	BLM 2018a
Flare at WPF	Operations: ≥ 25 years	71	29.3	11.8	28	USACE 2018

Note: Alt (alternative); ≥ (at least); dBA (decibels); Lmax (short-term, maximum sound level), WPF (Willow processing facility); yrs (years)
[a] 35 dBA is the ambient sound level in the analysis area.
[b] Assumes five pieces of heavy diesel equipment in operation concurrently.
[c] Alternatives B and D: 27.9 miles; Alternative C: 23.4 miles.
[d] Distance calculated from the Willow airstrip. Sound levels when aircraft are directly over Nuiqsut could range from 69 to 81 dBA if flying at a height of 1,000 feet. Typical flight paths from Kuparuk to Willow would pass approximately 8 miles north of Nuiqsut.

Drilling and operational noise would dominate the local soundscape but would dissipate to ambient levels as one moves farther from the source.

Subsistence users could be affected by noise if they are within the attenuation zone for noise sources, which are described in Table 3.6.3 and Figure 3.6.1. It is likely that subsistence users would avoid construction areas and areas of persistent operational noise (such as the WPF) and thus physical effects from noise on subsistence users would be minimal. The effects of avoidance of subsistence use areas as well as effects to subsistence resources and harvest are described in Section 3.16.

3.6.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be the same as described under Alternative B, with the following differences:

- Elimination of the gravel infield road between the WPF and BT1 would reduce some noise associated with construction and use of the road; however, construction and use of the annual ice road between the WPF and BT1 would generate noise during the winter.
- Removal of a bridge crossing over Judy (Iqalliqpik) Creek would eliminate construction related to the bridge, including impact pile driving.
- Relocation of the WPF, WOC, and airstrip approximately 5 miles east of the Alternative B location would result in slightly increased noise levels in Nuiqsut during construction and operation, although long-term operational noise would remain below ambient levels.
- Establishment of a second airstrip near BT2 would introduce construction and air traffic to another location; however, traffic at the BT2 airstrip would originate from the South WOC and would not be heard in Nuiqsut.

Although there are differences in the locations of some noise sources under Alternative C, any resulting differences in noise received in Nuiqsut would not be noticeable.

3.6.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be the same as described under Alternative B, with the following differences:

- Elimination of the gravel access road between GMT-2 and the WPF would reduce some noise associated with construction and use of the road; however, construction and use of the annual ice road between GMT-2 and the WPF would generate noise during the winter.
- The reduction of gravel roads would result in greater volumes of air traffic during both construction and operation and thus more incidents of aircraft-related noise.

Although there are differences in the locations of some noise sources under Alternative D, any resulting differences in noise received in Nuiqsut would not be noticeable.

3.6.2.6 Module Delivery Options

3.6.2.6.1 Option 1: Proponent's Module Transfer Island

Construction of an MTI at Atigaru Point would produce similar noises as described under Alternative B, except without drilling or processing facilities. Additional noise would arise from barging of materials and sealift modules (Table 3.6.4). Impact pile driving would produce substantial levels of impact noise for relatively short periods (days or weeks) and would be 31.1 miles from Nuiqsut, 7.1 miles farther than Alternative B.

Table 3.6.4. Construction Noise Unique to Module Delivery Options

Noise Source	Estimated Sound 1,000 feet from the Source (dBA)	Nearest Distance from Project Action to Nuiqsut (mi)	Distance to 35 dBAa (mi)	Estimated Sound at Nuiqsut (dBA)	Data Source
Tugboats, marine vessels, barges	40	23[b]	0.3	0	TORP Terminal LP 2009
Pile removal: vibratory method	75	31.1 to 72.2[b]	18	23.4 to 30.7 dBA	WSDOT 2015

Note: dBA (decibels); mi (miles)

[a] 35 dBA is the ambient sound level in the analysis area.

[b] Barges that originate from Oliktok Dock would be 23 miles from Nuiqsut at the closest point in transit. Proponent's Module Transfer Island is 31.1 miles from Nuiqsut; Point Lonely Module Transfer Island is 72.2 miles from Nuiqsut.

3.6.2.6.2 Option 2: Point Lonely Module Transfer Island

Option 2 would produce the same types and levels of noise as Option 1 except the noise would be farther away from Nuiqsut (Table 3.6.3 and Figure 3.6.1). Thus, impact pile driving would not be heard in Nuiqsut since the action would be over 72 miles from the community and noise would attenuate to ambient levels within 50.9 miles (Table 3.6.3). Point Lonely also has a slightly lower level of subsistence use than Atigaru Point and thus noise in this area would have a lower impact on subsistence users.

3.6.2.7 Oil Spills and Accidental Releases

Oil spills would not be a planned Project activity but were considered in the effects analysis for the Project. Chapter 4.0 (*Spill Risk Assessment*) describes the likelihood, types, and sizes of spills that could occur. Depending on the time of year (as well as the type and size of spill), boats, aircraft, trucks, and/or heavy equipment could be used to respond to the incident. Noise effects related to cleanup of very small to small spills, if they occur, would be similar to those of construction noise described above and occur mainly near the vicinity of the release. Noise effects related to cleanup of a large spill, if one were to occur, could be greater, occur over a longer duration, and over a larger area.

3.6.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Additional suggested mitigation measures to reduce noise impacts could include:

1. Altering flight paths to avoid sensitive areas (such as Nuiqsut)
2. Conducting noise monitoring during construction and operations
3. Using snow berms to dampen noise

3.6.4 Unavoidable Adverse, Irretrievable and Irreversible Effects

The LSs, BMPs, and mitigation measures are expected to reduce, but not eliminate, potential noise impacts. Noise impacts from construction and operation would be unavoidable. Such impacts would be irretrievable during the life of the Project but would not be irreversible as they would cease at Project end. Accordingly, this short-term use would not have noise-related impacts on the long-term sustainability of natural and human resources in the analysis area.

3.7 Visual Resources

Visual resources are visible features of the landscape and **scenic quality** is the measure of the visual appeal of a unit of land. Visual resources and scenic quality of the NPR-A are managed through the BLM **Visual Resource Management (VRM) system** (BLM 1984, 1986).

Qualitative indicators and quantitative measures of impacts used in this analysis focus on disclosure of impacts to scenery and to viewers. BLM **Visual Resource Inventories** (VRIs) were used to describe the baseline affected environment. The BLM **VRM classes** were used to assess Project conformance with BLM visual management objectives in the analysis area. This conformance was determined through the completion of Visual Contrast Rating Worksheets (Appendix E.7B, *Visual Contrast Rating Worksheets*).

The analysis area for visual resources is the area within line-of-sight from ground-eye-level to the tallest components of the Project (drill rig and communications tower lighting). For this Project, that area (also known as the **viewshed**) is 30 miles and includes the 0- to 5-mile **foreground-middleground distance zone** and the 5- to 15-mile **background distance zone** (Figure 3.7.1). The Project viewshed includes all areas from which the facilities would be visible based on topographical obstruction and distance. The temporal scale of visual resource impacts would be the life of the Project, until anthropogenic materials have been removed and reclamation activities are complete; recovery time of disturbed vegetation would be greater than 20 to 30 years (Everett 1980), as described in Section 3.9, *Wetlands and Vegetation*. If reclamation of gravel infrastructure does not occur, impacts would be permanent.

3.7.1 Affected Environment

The analysis area is characterized by slight topographic relief, 540 feet overall, and thermokarst ponds (USGS 2018). Harrison Bay (of the Beaufort Sea), the Colville River, numerous streams, and hundreds of ponds are the dominant visual features of ACP (Fenneman 1946). Vegetation is dominated by tundra grasses and shrub willows and the foreground-middleground landscape has few visually distinct features. Additionally, there is visible human infrastructure within the foreground-middleground landscape. The community of Nuiqsut, population 347 (U.S. Census 2018a), is in the analysis area (Figure 3.7.1). Other human development includes ice roads, snow and all-terrain vehicle (ATV) trails, as well as existing land disturbances and facilities associated with the GMT and Alpine developments, approximately 10 miles east of the proposed drill sites and pads. Besides oil and gas exploration and development, subsistence hunting and fishing are the dominant human activities in the analysis area (CPAI 2018b).

BLM VRI scenic quality evaluations (Figure 3.7.2), **sensitivity level** analyses (Figure 3.7.3), and **distance zones** (Figure 3.7.4) combine to establish **VRI classes** (Figure 3.7.5). Scenic quality is the relative worth of the landscape from a visual perception. Sensitivity level is the measure of public concern for the maintenance of scenic quality. Distance zones are a subdivision of the landscape as viewed from an observer position (BLM 1986).

VRI classes represent the relative value of visual resources, where VRI Class I is the most valued and VRI Class IV is the least. The analysis area is predominantly VRI Class IV (1,601,228 acres) and VRI Class III (117,975 acres), with VRI Class II present at Teshekpuk Lake and along the Colville River (828,267 acres) (Figure 3.7.5). Scenic quality in the analysis area is predominantly Class C (low quality), with Class A (high quality) present at Teshekpuk Lake and Class B (moderate quality) along the Colville River (Figure 3.7.2). Sensitivity levels throughout the analysis area are high. Distance zone visibility consists of the foreground-middleground (0 to 5 miles), background (5 to 15 miles), and **seldom seen** (greater than 15 miles) viewing situations (BLM 1984) from **key observation points** (KOPs). Stationary, linear, and area KOPs occur throughout the analysis area, at Nuiqsut, at overnight-stay sites, along travel routes, and at hunting and fishing areas.

VRM classes are management decisions on how visual resources are managed in conjunction with other uses in the NPR-A and are also assigned values of VRM Class I to VRM Class IV (Figure 3.7.6). These VRM classes were assigned to these lands by the NPR-A IAP/EIS (BLM 2012b). Project facilities would predominantly be located on BLM lands managed as VRM Class IV; however, Point Lonely and the surrounding area are VRM Class II (Figure 3.7.6). Tables E.7.5 and E.7.6 in Appendix E.7A summarize the acreages and percentages of the analysis area in the respective VRM and VRI classes. Appendix E.7 also includes the methods used to assess VRI impacts and VRM conformance descriptions and rationale as described below in Section 3.7.2, *Environmental Consequences*.

3.7.2 Environmental Consequences

3.7.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.7.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate visual impacts from development activity (BLM 2013a). The LSs and BMPs would reduce adverse visual impacts to the natural environment, from mobile and stationary viewing locations, created by structures, and equipment associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.7.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Visual Impacts

LS or BMP	Description or Objective	Requirement
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips.
BMP C-3	Maintain natural spring runoff patterns, avoid flooding, prevent streambed sedimentation and scour, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint. Project must consider sharing facilities with existing development or collocating oil and gas facilities.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.	Power and communication lines shall either be buried in access roads or suspended on vertical support members except in rare cases. Communication towers should be located on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities, should be avoided. Maintain a 1-mile buffer around all recorded Yellow-billed Loon nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline.
BMP E-17	Manage permitted activities to meet Visual Resource Management class objectives.	Submit a plan to best minimize visual impacts. At the time of application for construction of permanent facilities, the lessee/permittee shall submit a plan to best minimize visual impacts, consistent with the Visual Resource Management Class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain a specified minimum altitude in specified locations, generally at least 1,500 feet above ground level and at least 3,000 in some places.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.

LS or BMP	Description or Objective	Requirement
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat, prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters; consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses.

Source: BLM 2013a
Note: ADF&G (Alaska Department of Fish and Game); BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); USGS (U.S. Geological Survey)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect visual resources would include those to BMPs E-5, which would require a deviation because all alternatives would place new VSMs along existing pipeline corridors due to pipe rack capacity limits; and would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip.

3.7.2.2 Alternative A: No Action

Under Alternative A, the Project would not be constructed, although oil and gas exploration and development would continue to occur in the analysis area. Effects from existing development to visual resources (as described in Section 3.7.1, *Affected Environment*) would continue.

3.7.2.3 Impacts to Scenery Common to the Action Alternatives and Module Delivery Options

Project facilities and lighting under all action alternatives would affect scenery and people by impacting the undisturbed characteristic landscape (including night skies). Disturbance and lighting would cause the greatest visual impacts in foreground-middleground views. Impacts to scenic quality are based on estimated visual contrasts resulting from Project facilities and activities, including nighttime lighting, with VRI scenic quality ratings. A summary of how Project elements affect scenic quality is provided in Table 3.7.2.

Table 3.7.2. Impacts to Scenery Based on Visual Change to the Characteristic Landscape and Night Skies

VRI Scenic Quality Rating	Roads	Infrastructure and Pads	Drill Rigs and Module Transport Infrastructure[a]	Nighttime Lighting
Class A	Strong contrasts	Strong contrasts	Strong contrasts	Strong contrasts
Class B	Moderate contrasts	Moderate contrasts	Strong contrasts	Strong contrasts
Class C	Weak contrasts	Weak contrasts	Strong contrasts	Strong contrasts

Note: VRI (Visual Resources Inventory). Impact definitions: strong contrasts (Project element is dominant to the landscape and demands attention); moderate contrasts (Project element begins to attract attention); weak contrasts (Project element can be seen but does not attract attention). See BLM Manual 8431 (BLM 2012a) for detailed contrast definitions.
[a] Drill rigs would be present throughout drilling and operations; module delivery infrastructure would be present only during construction.

Impacts to people are determined based on the estimated contrasts caused by Project facilities, including nighttime lighting, with VRI sensitivity levels and distance zones (0 to 5 miles [foreground-middleground] and greater than 5 miles [background]). A summary of how Project elements affect people is provided in Table 3.7.3.

Table 3.7.3. Impacts to People Based on Visual Change to the Characteristic Landscape and Night Skies

High Sensitivity-Visibility-Distance	Roads	Infrastructure and Pads	Drill Rigs and Module Transport Infrastructure[a]	Nighttime Lighting
0 to 5 miles	Moderate contrasts	Moderate contrasts	Strong contrasts	Strong contrasts
Greater than 5 miles	Weak contrasts	Weak contrasts	Moderate contrasts	Strong contrasts

[a] Drill rigs would be present throughout drilling and operations; module delivery infrastructure would be present only during construction.

3.7.2.4 Alternative B: Proponent's Project

3.7.2.4.1 Impacts to Existing Visual Conditions

Due to the flat terrain in the analysis area, Project facilities and activities would impact subsistence users and visitors who would experience observable changes and contrasts to the characteristic landscape for the life of the

Project. Project facilities and activities with visual impacts would include lighting, structural features, drill rigs, communications towers, gravel roads, ice roads, a mine site, stockpiles, pipelines, boreholes, stream crossings, pilings, water intakes, screening areas, flares, vehicle activity, and air and ground traffic (Appendix E.7B, *Visual Contrast Rating Worksheets,* Worksheet VCRW-1). These strong contrasts to scenery would reduce the scenic quality rating of Class A landscapes (170,063 acres) and Class B landscapes (14,626 acres) (Figure 3.7.2). This would impact a total of 1,977,415 acres of BLM-managed land (44% of Project viewshed) in the currently undisturbed high sensitivity area (including 184,689 acres [4% of Project viewshed] inventoried as VRI Class II; 1,432,126 acres [32% of Project viewshed] inventoried as VRI Class III, and 360,601 acres [8% of Project viewshed] inventoried as VRI Class IV) (Figure 3.7.5).

In summary, the Project would result in moderate to strong contrasts to the landscape for viewers in foreground-middleground distance zones and weak to strong contrasts in background distance zones. The level of impact has the potential to impact visual sensitivity and reduce the scenic quality in approximately 184,689 acres of BLM lands that are currently inventoried as VRI Class II (Figure 3.7.5).

3.7.2.4.2 Conformance with Visual Resource Management

Conformance with BLM visual management objectives where Project facilities would be located is based on the Project's visual contrasts of forms, lines, colors, and textures (including nighttime lighting), with the characteristic landforms in the viewshed (Appendix E.7B, Worksheets VCRW-1, VCRW-2, VCRW-3). Alternative B would be in conformance with VRM objectives because all facilities would be located on Class IV lands, which are managed to allow for Project facilities that dominate the viewshed and attract the attention of the viewer (Figure 3.7.6). Tables E.7.3 and E.7.4 (in Appendix E.7A) provide the acreages and percentages of sensitivity classes and distance zones based on direct line-of-sight viewing conditions for facilities, activities, and night-sky conditions. Additional information regarding Project conformance with existing VRM classes is provided in the Visual Contrast Rating Worksheets in Appendix E.7B. Alternative B has no facilities in either VRM Class II or Class III areas.

3.7.2.5 Alternative C: Disconnected Infield Roads

Visual resource impacts to scenery, impacts to people, and conformance with VRM Class IV areas under Alternative C would be similar to Alternative B except there would be additional air traffic in the Willow area. (Ground and air traffic are detailed by season and alternative in Table E.11.8 in Appendix E.11, *Birds Technical Appendix*.)

3.7.2.6 Alternative D: Disconnected Access

Visual resource impacts to scenery, impacts to people, and conformance in VRM Class IV areas under Alternative D would be similar to Alternative C due to its similar increase in air traffic over Alternative B. (Ground and air traffic are detailed by season and alternative in Table E.11.8 in Appendix E.11.)

3.7.2.7 Module Delivery Options

Impacts to visual resources from module delivery options would be similar to those described above for the action alternatives in Tables 3.7.2 and 3.7.3. Module delivery options do have some impacts that would be unique to the marine area, including barge and support vessel traffic, creation and abandonment of MTIs, and onshore support. These impacts are described below.

3.7.2.7.1 Option 1: Proponent's Module Transfer Island

Effects to visual resources from Option 1 would include strong contrasts to the Beaufort Sea viewing environment due to the otherwise uniform forms, lines, colors, and textures of offshore and coastal views. Both the MTI and supporting ice infrastructure at Atigaru Point would occur in a VRM Class IV area and would conform with BLM management objectives.

3.7.2.7.2 Option 2: Point Lonely Module Transfer Island

Effects to visual resources from this option would be qualitatively similar to those from Option 1 but would be greater in magnitude. Option 2 would have approximately double the length of ice roads as Option 1. It would also have more air traffic, with approximately a quarter of that air traffic occurring at Point Lonely. Ground and air traffic are detailed by season and option in Tables E.11.9 through E.11.11 in Appendix E.11. The MTI for Option 2 would also be more visible to viewers onshore because it would be 0.6 mile from shore, whereas the MTI for Option 1 would be 2.4 miles from shore. Additionally, the MTI, onshore camp (on existing gravel pads), including communications towers, and some ice infrastructure at Point Lonely, would occur within a VRM Class II area and would not meet BLM management objectives because Project components would not blend into the existing landscape and would attract the attention of the casual observer. However, because the IAP allows for "construction, renovation, or replacement of facilities on the existing gravel pads at Camp Lonely and Point Lonely… if the facilities will promote safety or environmental protection," and limits VRM Class II application to those areas where new non-subsistence infrastructure is prohibited (BLM 2013a), Option 2 would be in conformance with the IAP. The use of existing gravel facilities would promote environmental protection, and the communications tower would promote safety.

3.7.2.8 Oil Spills and Accidental Releases

Oil spills would not be a planned Project activity but were considered in the effects analysis for the Project. Chapter 4.0 (*Spill Risk Assessment*) describes the likelihood, types, and sizes of spills that could occur. Depending on the time of year (as well as the type and size of spill), boats, aircraft, trucks, and/or heavy equipment could be used to respond to the incident. Visual resource impacts to scenery and to people related to cleanup of very small to small spills, if they occur, would be similar to those of construction described above and occur mainly near the vicinity of the release. Effects related to cleanup of a large spill, if one were to occur, could be greater, occur over a longer duration, and over a larger area.

In the very unlikely event that a **reservoir blowout** occurred at one of the drill sites (likelihood approaching zero as described in Chapter 4.0), the extent of the accidental release could be much larger and could distribute an aerial mist of oil over tundra vegetation as described in Chapter 4.0. A blowout could reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay, due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

Because oil, diesel fuel, and seawater spills on nonfrozen plants or soil could kill plants, effects may be visible on the landscape for many years. Seawater spills on salt-tolerant plants may be less visible on the landscape.

3.7.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented to minimize visual impacts and retain visibility of structures necessary for public safety. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Additional suggested mitigation measures to reduce visual impacts could include:

- Ensure structures are a color that blends in with the background colors of the natural landscape. All colors would be pre-approved by the BLM. Non-glare, self-weathering steel, or a BMP, would be used on all metal structures not otherwise painted, including but not limited to pipelines, communications towers and drill rigs.

3.7.4 Unavoidable Adverse, Irretrievable and Irreversible Effects

The LSs, BMPs, and mitigation measures are expected to reduce, but not eliminate, potential impacts. Visual impacts from construction and operation would be unavoidable and irretrievable throughout the life of the Project. Impacts would not be irreversible, nor would they impact long-term sustainability of visual resources in the analysis area if reclamation was completed. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.8 Water Resources

The analysis area for surface water resources is the watersheds in which Project actions or infrastructure would occur (Figure 3.8.1), as well as the groundwater aquifers contained therein, and the nearshore area of Harrison Bay near Atigaru Point and Point Lonely. This encompasses all waterbodies and aquifers potentially affected by the Project, including potential downstream effects. The temporal scale for construction-related impacts is the duration of construction activities. The temporal scale for infrastructure created during construction would be the life of the infrastructure until it is removed.

3.8.1 Affected Environment

The analysis area is on the ACP, which drains to the Beaufort Sea. It is characterized by low relief, continuous permafrost, and numerous lakes (Stuefer, Arp et al. 2017).

3.8.1.1 Surface Waters

Surface water (rivers, shallow streams, lakes, and ponds) hydrology is influenced by low precipitation, relatively flat topography, and the poorly drained tundra underlain by continuous permafrost. The surface waters in the analysis area generally begin to freeze in September or October and thaw in late May or early June. The annual hydrologic cycle is dominated by an approximately 3-week spring breakup characterized by snowmelt runoff, **overland flow**, higher than average stream flows, and overbank flooding in about half the years.

Limited gravel roads, pads, bridges, and other infrastructure exist in the analysis area from oil and gas development or decommissioned Distant Early Warning (DEW) Line sites. Seasonal ice roads and pads (and associated water withdrawal) may occur annually to support oil and gas exploration. Gravel infrastructure from the GMT-1 and Alpine developments exists in the lower reaches of the Ublutuoch (Tiŋmiaqsiġvik) River and Fish (Iqalliqpik) Creek basins, and new gravel infrastructure for GMT-2 will be constructed to the southwest of GMT-1 in 2019 (Figure 3.8.1). The existing infrastructure and development activities (traffic, dust suppression, drilling, processing, etc.) have constructed structures in waterbodies, contribute dust and sediment to waterbodies, withdraw freshwater for use throughout the year, and increase the potential for spills entering waterbodies.

3.8.1.1.1 Rivers

The largest rivers in the Willow area are the Kalikpik River, Fish Creek (both the Uvlutuuq and Iqalliqpik channels), Judy Creek (Kayyaaq and Iqalliqpik channels), and the Ublutuoch (Tiŋmiaqsiġvik) River (Figures 3.8.1 and 3.8.2). Streamflow in these rivers is seasonal, with the highest **discharge** during spring snowmelt (late May to mid-June). Flows are usually lowest (at or near 0 cubic feet per second [cfs]) from November through April for the largest rivers and for even longer periods for the smaller streams. Snow and ice blockage at the time of peak **stage** and peak discharge can influence **water surface elevations** (WSEs) in these streams and rivers. The riverbeds in all channels of Fish and Judy creeks are highly mobile when compared to the riverbeds of similar sized streams east of the Colville River Delta (CRD), and thus may have deeper scour depths (i.e., riverbed erosion). Table 3.8.1 summarizes existing conditions of the largest rivers in the Willow area. Appendix E.8, *Water Resources Technical Appendix,* provides details of large rivers and small streams, including (where available) descriptions of the locations at which monitoring has occurred, descriptions of the snow and ice conditions at breakup (including cross-sections showing the magnitude of the impact), spring-peak-discharge and spring-peak-stage measurements, summer stage and discharge measurements, riverbed movement measurements, and median riverbed material size. Modeling of the floodplain at the Project stream crossings indicates that for most of the streams in the Willow area, the floodplain is limited to a very narrow area (Figure 3.8.3); the floodplains for Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek are wider.

Table 3.8.1. Summary of Largest Rivers in the Willow Area

Characteristic	Kalikpik River	Fish Creek (Uvlutuuq and Iqalliqpik)	Judy Creek (Kayyaaq and Iqalliqpik)	Ublutuoch (Tiŋmiaqsiġvik) River
Drainage area (square miles)	264	215[a]	385	236
Receiving waters	Harrison Bay	Harrison Bay	Fish (Iqalliqpik) Creek at RM 26	Fish (Iqalliqpik) Creek at RM 10
Headwaters	Arctic Coastal Plain	Brooks Range Foothills	Brooks Range Foothills	Arctic Coastal Plain
Channel character in Project area	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks	Relatively low gradient, sinuous channel with sand and gravel bed and banks
Tributaries that intersect Project	None	Judy (Kayyaaq and Iqalliqpik) Creek[a], Ublutuoch (Tiŋmiaqsiġvik) River[a], and Willow Creek 8	Judy (Kayyaaq) Creek, Willow Creek 1, 2, 3, and 4	Bill's Creek
Primary flood-event driver	Spring breakup	Spring breakup	Spring breakup	Spring breakup
Observed conditions affecting annual peak WSEs and WSE at time of annual peak discharge	Snow and ice in channel and on floodplain.	Snow and ice in channel and on floodplain, and ice jams.	Snow and ice in channel and on floodplain, and ice jams.	Snow and ice in channel and on floodplain.

Characteristic	Kalikpik River	Fish Creek (Uvlutuuq and Iqalliqpik)	Judy Creek (Kayyaaq and Iqalliqpik)	Ublutuoch (Tiŋmiaqsiġvik) River
Bank erosion	NA	Under-cutting and sloughing observed along the outside of meander bends.	Under-cutting and sloughing observed along the outside of meander bends.	NA
Spring breakup monitoring record	1 season of stage data at RM 21.8 (Kal 1). No observed peak discharge information available.	17 seasons of stage and discharge data at RM 32.4, median observed spring peak discharge 3,370 cfs. 1–5 seasons of stage (and sometimes discharge) data at RMs 11.7, 12.6, 18.4, 25.1, 32.4, 43.3, and 55.5.	17 seasons of stage and discharge data at RM 7, median observed spring peak discharge 4,770 cfs. 1–7 seasons of stage (and sometimes discharge) data at RMs 13.8, 16.5, 21.4, and 31.1.	17 seasons of stage and discharge data at RM 13.7, median observed spring peak discharge 1,700 cfs. 1–8 seasons of stage (and sometimes discharge) data at RMs 6.8, 8.0, 13.5, 14.5, and 15.5.
Summer monitoring record	1 season of stage data at RM 21.8 (Kal 1).	17 seasons of stage and discharge data at RM 32.4. 1 season of stage data at RM 55.5.	17 seasons of stage and discharge data at RM 7. 1 season of stage data at RM 21.4.	17 seasons of stage and discharge data at RM 13.7.
Water quality record[b]	2 summers of data just upstream of BT4	2 summers of data from Uvlutuuq just upstream of proposed road crossing	2 summers of data from Judy (Kayyaaq) Creek near BT1	2 summers of data from Bills Creek
Existing infrastructure in basin	None	GMT-1, GMT-2	None	GMT-1, GMT-2, and Alpine CD5

Note: BT1 (Bear Tooth drill site 1); BT4 (Bear Tooth drill site 4); CD (Colville Delta); cfs (cubic feet per second); GMT (Greater Mooses Tooth); Kal 1 (Kalikpik gauging station at RM 21.8); NA (not applicable); RM (river mile); WSE (water surface elevation)

[a] Drainage area does not include the tributary basins of Judy (Kayyaaq and Iqalliqpik) Creek and Ublutuoch (Tiŋmiaqsiġvik) River, which are calculated separately as shown in Figure 3.8.1. The drainage area for all three Hydrologic Unit Codes is 836 square miles.

[b] Water quality data are described in Section 3.8.1.1.3, *Freshwater Water Quality*.

3.8.1.1.2 Lakes and Ponds

Lakes are the most common hydrologic surface water feature in the analysis area (Figure 3.8.4). Shallow lakes and ponds (<7 feet deep) dominate the analysis area, but lakes up to 27 feet deep also exist. Shallow waterbodies freeze to the bottom in winter and thaw by the end of June. Deeper lakes generally have free water under the ice and provide a source of water year-round. Lakes in the analysis area recharge through three mechanisms: snowmelt, overbank flooding from nearby streams, and rainfall (BLM 2014a).

Lakes in the analysis area were sampled in the summers of 2017 (31 lakes) and 2018 (47 lakes) to identify possible sources of fresh water (McFarland, Morris et al. 2017b; McFarland, Morris, Moulton, and Moulton 2019). Lake volume varied from 22 to 3,209 MG, and maximum depth varied from 4.2 to 29.9 feet. Lake M0015 (R0056) and Lake R0064 are proposed as potable water sources. Lake M0015 has an estimated volume of 615 MG, and at the time of sampling in July 2018, a maximum depth of 6.7 feet, temperature of 17.3ºC, turbidity of 8.1 NTU, and pH of 8.0 units. Lake R0064 has an estimated volume of 571 MG, a maximum depth of 5.7 feet, and at the time of sampling in August 2015, a turbidity of 1.3 NTU and pH of 8.3 units (CPAI 2018b).

3.8.1.1.3 Freshwater Water Quality

Most fresh waters in the NPR-A are considered pristine (BLM 2012). Limited data on surface water quality in the analysis area (McFarland, Morris et al. 2017a, 2017b; McFarland, Morris, Moulton, and Moulton 2019; McFarland, Morris, Moulton, Moulton et al. 2019) indicate it is generally good and meets **Alaska water quality standards**. Water quality data for freshwaters in the Willow area are summarized in Table 3.8.2. No fresh waterbodies are listed as impaired by ADEC on its CWA Section 303(d) list (ADEC 2018a), though absence of listing does not indicate that a waterbody meets water quality standards since data may not be available for all waterbodies. The CWA Section 303(d) list includes waterbodies in which one or more **water quality criteria** are not attained or waterbodies that are impaired for at least one **designated use**.

Table 3.8.2. Water Quality Data for Rivers, Streams, and Lakes in the Willow Area

Waterbody	Water Temperature (°C)	Turbidity (NTU)	pH Range
Kalikpik River	2.7 to 18.9	2.1 to 14.9	7.7 to 8.1
Fish (Uvlutuuq) Creek	3.2 to 18.4	2.5 to 31.9	7.6 to 8.0
Judy (Kayyaaq) Creek	3.5 to 16.9	1.4 to 12.8	6.9 to 8.1
Judy (Iqalliqpik) Creek	3.7 to 17.9	2.7 to 34.1	7.3 to 8.4
Ublutuoch (Tiŋmiaqsiġvik) River, Bills Creek	2.7 to 17.0	0.43 to 5.0	7.4 to 7.9
Willow Creek 1	3.4 to 18.1	0.7 to 11.6	6.8 to 8.3
Willow Creek 2	3.0 to 18.0	0.4 to 28.2	7.2 to 8.1
Willow Creek 3 (July only)	11.0 to 13.9	1.3 to 33.3	7.7 to 8.2
Willow Creek 4	3.7 to 17.8	0.5 to 4.3	7.0 to 8.3
Willow Creek 4A	3.6 to 18.7	0.7 to 25.7	7.2 to 7.7
Willow Creek 8	3.9 to 18.3	0.7 to 19.0	7.0 to 7.9
Lakes[a]	6.6 to 17.7	0.5 to 8.1	6.9 to 8.4

Note: NTU (Nephelometric Turbidity Units). Data collected in summer 2017 and 2018.
Source: (McFarland, Morris et al. 2017a, 2017b; McFarland, Morris, Moulton, and Moulton 2019; McFarland, Morris, Moulton, Moulton et al. 2019)
[a] Lake volume ranged from 22 to 3,209 MG, and maximum depth varied from 4.2 to 29.9 feet.

Turbidity in lakes and streams is naturally high during spring breakup, but otherwise generally low. Lakes on the ACP generally have lower pH values in the winter months, due in part to the **ice exclusion process** (that occurs during freeze-up). This natural process causes pH to be seasonally below water quality standards even in natural conditions. It may also cause turbidity to increase with depth in winter. Both conditions typically cease with spring breakup. During the summer, turbidity may be higher in shallower lakes than deeper lakes due to wind mixing.

North Slope freshwater can also be naturally high in barium (Guay and Falkner 1998). Ponds and local streams are often colored from dissolved organic matter and iron, and most fresh waterbodies in the NPR-A have low turbidity and dissolved oxygen near saturation.

Fecal contamination above Alaska water quality standards may naturally occur in areas with dense avian, caribou, and lemming populations. Cold water temperatures tend to prolong the viability of fecal coliform.

3.8.1.1.4 Marine Waters

Harrison Bay spans approximately 62 miles of coastline between Oliktok Point and Cape Halkett. It is the receiving waters for most freshwaters in the analysis area. Sediments on the nearshore Beaufort Sea continental shelf consist primarily of mud, with some coarser material. Sediments tend to be coarser grained closer to shore and in shallower water depths due to wave and current winnowing, with finer-grained sediment further from shore and at deeper water depths (Carey, Ruff et al. 1981). The nearshore waters are most influenced by river input but are also affected by processes offshore in the deep basin, such as currents. During the open-water season, surface currents are primarily wind driven close to shore. Coastal upwelling contributes to the high productivity of such environments (Bakun 1973). Ice covers the sea for up to 9 months of the year, generally from September to May (North Pacific Fishery Management Council 2009). The thickness of **bottom-fast ice** near the CRD at the end of the winter season averages about 5.2 feet (Dodds and Richmond 2017 as cited in MBI 2017). Ice movement onto shore during wind-driven events causes scouring and trenching and can seasonally alter the shoreline.

Harrison Bay has an average tidal range of 0.5 foot, which is generally overshadowed by storm surges and wind-induced waves (USACE 2018). During open-water season, water circulation is dominated by prevailing northeasterly winds. In winter, ice becomes bottom-fast in water less than 5 feet deep (Weingartner, Danielson et al. 2017).

Harrison Bay is sheltered from the wave energy from the northwest. The area near Atigaru Point is influenced by the sediment released by coastal erosion and the sediment load from the Colville River. Sediment transport by the longshore current is relatively low. The coastline of Harrison Bay is predominantly erosional (Gibbs and Richmond 2015). Though a shoal occurs near Atigaru Point, it has had little deposition (0.06 foot/year) in the last 65 years (CPAI 2019a).

No marine infrastructure exists in the analysis area. No marine waterbodies in the analysis area are listed as impaired by ADEC on its CWA Section 303(d) list (ADEC 2018a). During most of the winter season, when ice covers the sea surface and river discharge is negligible, background levels of total suspended solids (TSS) in the nearshore Beaufort Sea typically range from 0.1 to 0.5 milligrams per liter (mg/L) (Trefry, Rember et al. 2004). During the spring freshet, however, when river discharge occurs prior to breakup of the sea ice, substantial increases in TSS occur. Measurements obtained in 2001 and 2006 documented mean values of 343 and 785 mg/L, respectively, in the Colville River (Trefry, Trocine et al. 2009). During the open-water season, nearshore TSS values in the Beaufort Sea are governed primarily by the wave conditions, which in turn are governed by the wind conditions. Concentrations tend to range from 5 to 15 mg/L when wind speeds range from 10 to 20 knots, and 50 to 100 mg/L when the wind speeds exceed 20 knots (Trefry, Trocine et al. 2009). Wind data obtained at the mouth of the Colville River during the 2001 open-water season indicate that speeds of 10 to 20 knots occur about 49% of the time, while those greater than 20 knots occur about 8% of the time.

3.8.1.2 Groundwater

The availability of groundwater in the analysis area is limited due to the presence of continuous permafrost on the North Slope (BLM 2014a). The groundwater is confined to shallow zones near large surface waterbodies such as lakes, streams, and rivers. The areas that contain groundwater, predominantly taliks (i.e., layers of unfrozen ground occurring in permafrost), are recharged primarily with snowmelt.

Deep groundwater, though present, generally is not connected to the surface water system because permafrost acts as a barrier (NRC 2003). Some sub-lake taliks extend through permafrost, but no connection between sub-permafrost groundwater and surface water has been demonstrated (Hinkel, Arp et al. 2017). Deep groundwater on the North Slope is saline (Kharaka and Carothers 1988; Sloan 1987), and is not a source of potable water.

3.8.2 Environmental Consequences

3.8.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.8.3 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate water resource impacts from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to human health and safety, fish, waterfowl and invertebrate habitat, and subsistence hunting and fishing areas, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.8.3. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Water Resources

LS or BMP	Description or Objective	Requirement
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.

LS or BMP	Description or Objective	Requirement
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation is prohibited. Vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.
BMP C-4	Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.	Travel up and down streambeds is prohibited unless demonstrated that there will be no additional impacts to over-wintering fish or the invertebrates they rely on.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet of fish-bearing waterbodies. Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program shall be required to address the objectives of water quality and free passage of fish.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies. The plan must consider: a. Locations outside the active flood plain. b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use. c. Potential use of the site for enhancing fish and wildlife habitat. d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.
BMP E-14	Ensure the passage of fish at stream crossings.	To ensure that crossings provide for fish passage, all proposed crossing designs shall collect at least 3 years of hydrologic and fish data.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.

LS or BMP	Description or Objective	Requirement
LS/BMP K-1	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or over-wintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).
BMP K-4a	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins.
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; protect summer and winter shoreline habitat; prevent loss or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/ USGS drill sites and Distant Early Warning-Line sites.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain adequate habitat for birds, fish, and terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); USGS (US Geological Survey)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect water resources would include those to LS E-2 and BMPs E-5, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. BMP E-5 would require a deviation because all alternatives would place new VSMs along existing pipeline corridors due to pipe rack capacity limits; and would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip.

3.8.2.2 Alternative A: No Action

Under the No Action Alternative, ice infrastructure and associated water withdrawals in the analysis area could continue to occur to support oil and gas exploration. Effects from the existing gravel infrastructure in the Alpine and GMT oilfields would continue, as described in Section 3.8.1.1, *Surface Waters*. No new infrastructure would be constructed for the Project.

3.8.2.3 Alternative B: Proponent's Project

Project activities with the potential to affect water resources would include gravel mining; construction and use of ice and gravel infrastructure; construction and use of in-water structures (bridges, culverts, and water intakes) and pipelines; water withdrawals; and wastewater disposal. Effects of these activities on water resources are discussed below.

3.8.2.3.1 Gravel Mining

Water resources could be impacted by gravel mine excavation and dewatering. Gravel mining at the Tiŋmiaqsiuġvik mine site would occur in winter, over several construction seasons. Berms constructed of excavated overburden would be placed around the excavated area to prevent surface flows to or from the mine. When gravel extraction for a season is complete, the overburden would be placed back in the mined area, leaving a depression. The depression would impound precipitation and meltwater from adjacent seasonally thawed permafrost.

Thermokarst erosion from ponded water may increase suspended solids (SS) and turbidity in surface water in the mine pit, which would be likely to settle within several years after the site has stopped filling (Ott, Winters et al. 2014). Stormwater runoff during mine development could also increase SS and turbidity; however, runoff would be contained in the mine pit and the pit would be dewatered in the fall preceding the winter in which mining would occur. Potential pollutants in gravel mine dewatering effluent include SS and petroleum hydrocarbons. Mine dewatering would be covered under APDES General Permit AKG332000, which authorizes wastewater discharges to tundra, freshwaters, and marine waters from oil and gas related facilities. The permit requires development and implementation of BMPs to avoid and minimize impacts to water quality.

Damage to the permafrost from mining would be permanent, and so would the resulting impoundment of water. The mine site would be reclaimed based on input from the Alaska Department of Fish and Game and BLM, and it could be connected to adjacent streams to provide deepwater fish habitat.

3.8.2.3.2 Ice Infrastructure

Seasonal ice roads and pads would be used for 7 years during construction. Alternative B would construct a total of 372.0 miles of ice roads. Ice infrastructure can block or restrict the flow of surface water during spring breakup if located on or near natural drainage paths, diminishing their capacity to convey water, and potentially lead to impoundment of flow, changes in channel stability and alignment, and erosion.

Ice road construction over lakes that do not freeze to the bottom could affect dissolved oxygen concentrations. Many of these lakes are just a foot to a few feet deeper than the minimum 6-foot depth necessary to maintain some unfrozen bottom water in winter (BLM 2004a). An ice road across a lake with such an intermediate depth could freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. As a result, mixing would be reduced and isolated pools with low oxygen could occur. Dissolved oxygen concentrations could be reduced below the 5 mg/L criterion needed to protect resident fish (18 AAC 70), but concentrations would increase to above that criterion after surface ice thaws in the spring. Ice roads across lakes shallower than 5 feet or greater than 8 feet would not be expected to have negative effects since the shallower lakes freeze to the bottom regardless of road presence and the water under the ice in deeper lakes would remain unfrozen.

Depending on the source of ice and water used to create ice roads and pads, the meltwater in the spring could have a temporary localized effect on specific conductance, alkalinity, and pH in the surrounding waterbodies. Water quality effects would be temporary and would likely return to existing conditions after spring recharge.

3.8.2.3.3 Gravel Infrastructure

Alternative B would construct 442.7 acres of gravel infrastructure in winter when waterbodies would be frozen. Gravel infrastructure could increase turbidity and SS in surface waters surrounding the gravel fill during the spring thaw and summer rainfall events when runoff may entrain fine-grained fill material. Runoff would be localized and minimally increase the quantity of runoff and sediment to any single receiving drainage (may not be noticeable compared to background turbidity during breakup or rainfall events). Runoff would be sporadic and would occur over the life of the Project.

Use of the gravel infrastructure would create dust, the vast majority of which would settle within 328 feet (100 m) of the roads and pads. Dust from vehicle traffic would increase turbidity in waterbodies directly adjacent to gravel roads and pads. Dust would also settle onto surrounding vegetation, snow, and ground. This could decrease albedo, increase thermal conductivity, promote earlier spring thaw than in surrounding areas, and lead to ground subsidence from the melting of ice-rich sediments (Everett 1980; Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987). The dust shadow is detailed in Section 3.4, *Soils, Permafrost, and Gravel Resources*, and would occur throughout the life of the Project.

Gravel infrastructure could result in upslope water impoundment and thermokarst erosion next to areas covered by gravel fill (Walker, Webber et al. 1987). Thermokarst erosion caused by both the disturbance of tundra and by the thermal effect of dust blown off the gravel onto the tundra, can result in water features with high turbidity and SS. Thermokarst erosion could cause the water quality criteria to be temporarily exceeded within and downgradient of thermokarst features throughout the life of the Project.

Gravel infrastructure would be permanently located in the 50- or 100-year floodplain of Fish (Uvlutuuq) Creek, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, Willow Creek 2, Willow Creek 4, Willow Creek 4A, and Willow Creek 8 (Figures 3.8.2 and 3.8.3). Though the floodplain at most of the stream crossings is limited to a very narrow area (barely visible in the figures), the floodplains for Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek are wider and would encompass the gravel road on either side of the crossing. If gravel roads or pads block or restrict the flow of surface water during spring breakup, they may: 1) increase the depth and duration of water impoundment, 2) increase thermokarsting, 3) cause a change in flow direction, 4) cause channel instability or a change in alignment, 5) result in erosion of the tundra or a stream channel, or 6) result in deposition of sediment on the tundra or in a stream channel. Effects 1 through 3 would occur on the upstream side of the road or pad; Effects 4 through 6 could occur on either the upstream or the downstream side of the road or pad. If the blockages were fixed within the year in which they were first observed, did not overtop the road or pad, and did not drain along the upstream side of the road, the resulting impact of the blockage would be measurable but would not require rehabilitation. However, thermokarsting that resulted from water impoundments resulting from blockages would create a depression that would last indefinitely. If the blockage caused a change in flow direction, channel instability, erosion of the tundra or stream channel, or resulted in deposition of sediment on the tundra or in the stream channel, the resulting impact would be measurable and require rehabilitation. The impact could be visible for many years, even with rehabilitation.

3.8.2.3.4 In-Water Structures (Bridges, Culverts, Water Intakes)

Hydrologic changes to surface waters could result from the installation and use of culverts and bridges. Alternative B would construct 11 culvert batteries and 7 bridges, with 56 bridge piles below ordinary high water (OHW), see Figure 3.8.5. The installation of culverts and bridges may cause temporary increases in SS and turbidity. The increases in SS and turbidity would likely be indistinguishable from background conditions during high flow events. Piles would be driven in winter through bottom-fast ice, thus minimizing the potential for water quality impacts. During the life of a bridge or culvert, possible impacts to the stream include increased backwater on the upstream side of the structure; increased riverbed erosion within the bridge opening; increased riverbed and bank erosion downstream of the structure; increased sediment deposition downstream from the structure; increased sediment transport downstream from the structure; and a change in channel morphology downstream from the bridge. Appendix E.8 provides more details about the likelihood and extent of these effects, including a discussion about the flood event to which structures were designed and the probability of exceedance of that event. If one of these effects were to occur, it would occur immediately upstream and downstream of the structure.

3.8.2.3.5 Pipelines

All of the pipeline waterbody crossings would be aboveground on VSMs except for the Colville River crossing, which would be installed 85 feet belowground using HDD. Approximately 14 VSMs would be below OHW.

VSM installation would occur in winter and thus would not affect water quality. Once installed, the VSMs would increase water velocity immediately adjacent to the VSMs and scour holes would likely form around the VSMs during high water. The scour hole would not compromise pipeline integrity as long as the design properly considers the depth of the scour hole. Additionally, the material from the scour hole would be transported and deposited downstream.

The pipeline crossing of the Colville River would be located just north of the existing Arctic Slope Regional Corporation Mine Site (Figure 3.8.1). Drill cuttings and drilling fluids (also called mud) from the HDD process would not be discharged to surface water or the tundra but would be transported to an existing permitted UIC well for disposal or would be temporarily stored until an on-site Class I UIC disposal well is operational. During installation, there is a potential that the drilling fluid used to bore the pipeline below the streambed could be released into the stream through fractures, a process called a **frac-out**. If a frac-out occurs, the sediment load of the stream would increase. The magnitude of the impact would depend upon how fast the frac-out is recognized and the characteristics of the flow in the stream at the time of frac-out. Drilling fluids would consist of a slurry of naturally occurring nontoxic materials (typically bentonite clay and water) and would not cause other water quality effects.

No other impacts to surface or ground waters are anticipated if current BMPs are followed.

3.8.2.3.6 Water Withdrawal

Alternative B would withdraw 1,874 MG of freshwater from lakes over the life of the Project. Water would be used for four primary uses: 1) ice roads and pads during winter construction, 2) hydrostatic testing of pipelines (once at the end of construction), 3) dust suppression throughout the project, and 4) as a potable water source during operations. Lake M0015 (R0056) and Lake R0064 would be used as potable water sources. Lake M0015 (R0056) has an estimated volume of 643 MG with a maximum recommended winter withdrawal volume of 8.85

MG, and Lake R0064 has an estimated volume of 1,570 MG with a maximum recommended winter withdrawal volume of 11.4 MG, as per Alaska Department of Natural Resources' (ADNR's) water withdrawal calculation guidelines (ADNR n.d.).

Winter water withdrawal from lakes would gradually lower the water levels through each winter of construction. However, spring recharge should replace the withdrawn volumes in the lakes in most years. Exceptions could occur in dry years when a lake might require a year or longer to recover. Anticipated water withdrawal volumes over the life of the Project are detailed in Table E.8.10 in Appendix E.8. Water withdrawal in the winter would potentially alter lake-water chemistry temporarily (until spring breakup and recharge) by depleting oxygen and changing pH and conductivity. Summer potable water withdrawal would have no effect on water quality since ice exclusion would not be occurring (Section 3.8.1.1.2, *Lakes and Ponds*).

3.8.2.3.7 Wastewater Disposal

Several types of wastewater would be produced during the project: domestic wastewater, hydrostatic test water, runoff to secondary containment areas that must be dewatered, and drilling fluids and wastes. Most wastewater would be disposed into a Class 1 UIC disposal well. (Wastes allowed for injection include treated domestic wastewater, drilling muds and cuttings, well workover fluids, melt and storm water, produced water, and other exempt and non-exempt non-hazardous fluids. The UIC permitting process requires an applicant to provide supporting information beyond what is included in this EIS, including, but not limited to, data regarding topography, geology, hydrogeology, nearby wells, well construction, well operation, monitoring, aquifer exemptions, and waste description.) Hydrostatic test water would be filtered, tested, and discharged to the tundra under the guidelines of APDES General Permit AKG332000. The purpose of hydrostatic testing is to test for leaks in the newly constructed pipelines prior to use; thus, test water would be from clean pipes and would not be expected to affect water quality.

Domestic wastewater (sewage) would be treated at the Project's wastewater treatment facility (at the WOC) and disposed into a Class 1 UIC disposal well. Domestic wastewater generated prior to UIC well completion (i.e., during construction) would be transported by tanker truck to an existing permitted UIC site at Alpine or Kuparuk (in winter only). In instances where weather or conditions at Alpine prevent transport to or disposal at the site, treated domestic wastewater would be discharged to the tundra, per the conditions of APDES General Permit AKG572000. This permit (which authorizes wastewater discharges to tundra, freshwaters, and marine waters) stipulates effluent limits for pH, chlorine, dissolved oxygen, biochemical oxygen demand, solids, and bacteria. Monitoring is required for ammonia as nitrogen. After the Class I UIC well is established, discharge of treated domestic wastewater to the tundra or surface water is not proposed under normal operating conditions. If this is not possible, such as during maintenance or equipment malfunction, treated wastewater would be trucked to Alpine, or in emergency situations only, discharged to the tundra.

Transferring domestic wastewater to and from tanker trucks could result in the accidental release of domestic wastewater. Potential pollutants in domestic wastewater include total residual chlorine, dissolved oxygen, biochemical oxygen demand, solids, fecal coliform and enterococci bacteria, and nitrogen, which may potentially impact water quality. Such spills are not likely to have concentrations of pollutants that are toxic or hazardous to the environment, but they could cause exceedances of water quality criteria. Domestic wastewater spills are usually small (less than 20 gallons) and would typically occur on ice or gravel infrastructure during pumping or transferring or could result from frozen lines rupturing.

Wastewater disposed into the Class I UIC well could interact with deep groundwater within the bedrock formations in which the wastewater would be injected; however, no negative effects would be anticipated. It would be highly unlikely that deep groundwater injected with waste fluids would travel laterally or vertically and intersect surface waters. The bedrock units in which waste fluids would be injected are thousands of feet deeper than the ocean floor, and often deeper than the hydrocarbon producing zones of the bedrock, making such an occurrence improbable (NRC 2003). If such an occurrence were possible, it likely would have been previously observed in numerous locations offshore from existing major oil fields (NRC 2003).

The Project's Class I disposal wells would not impact a source of potable groundwater, because the aquifers beneath the permafrost are saline and are not sources of drinking water. All waste injection would be in compliance with UIC permit stipulations.

3.8.2.3.8 Stormwater Runoff

Runoff may occur from stormwater (which includes rainfall and snowmelt) on structures, gravel infrastructure, and from water applied to gravel roads and pads for dust suppression. Stormwater discharges may contain sediment and residues or contaminants from equipment or vehicle drips and leaks (Chapter 4.0, *Spill Risk Assessment*) on pads and roads. Pads and roads would be designed to limit point sources of runoff to the surrounding tundra: both snowmelt and rain water on the pad would primarily seep directly through the gravel.

Stormwater discharges from the Project would be authorized and regulated under APDES General Permit AKG332000. As required under this permit, the Project includes development and implementation of a SWPPP for runoff from Project facilities. Under implementation of the SWPPP, water quality effects (increased turbidity, decreased dissolved oxygen, and increased levels of contaminants) would be minimized. Effects would occur primarily surrounding Project infrastructure.

3.8.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences: there would be 1 fewer bridged stream crossing, 1 less culvert battery, and 20 fewer piles below OHW and thus fewer structures below OHW to cause changes to hydrology and water quality. There would be 1 additional seasons of ice roads and water withdrawal during construction as well as an annual ice road required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative C would have 528.0 more acres of ice infrastructure (3,400.3 acres total) and 173.2 MG more water withdrawals (2,047.2 MG total) that could cause changes to water quality in water source lakes and changes to hydrology around the compacted ice and snow. Alternative C would also require the use of ice roads throughout operations, so effects would last throughout the life of the Project. See Appendix E.8 for details on the comparison of effects among alternatives.

3.8.2.5 Alternative D: Disconnected Access

Effects on water resources under Alternative D would be similar to those under Alternative B, with the following differences (Appendix E.8 for details): there would be 1 fewer bridge, 3 less culvert batteries, and 4 fewer piles below OHW and thus fewer structures below OHW to cause changes to hydrology and water quality. There would be 2 additional seasons of ice roads and water withdrawal during construction as well as an annual ice road required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative D would have 1,578.9 more acres of ice infrastructure (4,451.2 total acres) over the life of the Project and use 559.8 MG more freshwater (2,433.8 MG total), which could cause changes to water quality in water source lakes and changes to hydrology around the compacted ice and snow. Alternative D would also require the use of ice roads throughout operations, so effects would last throughout the life of the Project. Alternative D would also have additional miles of diesel pipeline (on the same VSMs as the Willow Pipeline), so would have more pipelines from which a spill could occur.

3.8.2.6 Module Delivery Options

Effects to water resources from module delivery options are summarized in Table 3.8.4. Some of the types of effects are similar to those described above for the land-based alternatives. Effects that would be unique to the marine area are detailed in the subsequent sections.

3.8.2.6.1 Option 1: Proponent's Module Transfer Island

Gravel fill for Option 1 would be placed during winter through a hole cut in the bottom-fast ice. The Atigaru Point area has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). Mobilization of fine-grained material in the MTI fill into the water column or from in-water work (screeding or recontouring of the MTI slopes), would occur during the summer construction season. A turbidity plume of about 11 to 15 acres is expected based on wind and currents (Coastal Frontiers Corporation 2018b). The duration of the plume would depend on the quantity of fines in the fill and could last 0.5 hour to 55 days (Coastal Frontiers Corporation 2018b).

Approximately 4.9 acres in front of the MTI dock would be screeded two times over the life of the MTI. A temporary increase in turbidity during and immediately after screeding would occur. Pile and sheet pile driving for MTI construction would occur in winter through bottom-fast sea ice, thus they would not increase turbidity during installation.

Based on data for western Harrison Bay, current speeds are too low to cause significant, permanent scour of the sea bottom surrounding the MTI (Coastal Frontiers Corporation 2018a). Average rates of shoaling in the area are low (CPAI 2019a). Other human-made islands in the Beaufort Sea experience small amounts of shoaling on the leeward side. Similar amounts would be expected at the MTI and would not affect the stability of the MTI or coastal processes around it. No accretion or further shallowing of the MTI area would be expected to occur.

Table 3.8.4. Effects to Water Resources from Module Delivery Options

Project Component	Effects on Fish or Fish Habitat	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Gravel fill in marine area	Temporary increase in SS or turbidity Changes to sediment transport and deposition Scour or accretion	12.8 acres of fill 11- to 15-acre sediment plume lasting ~55 days No significant scour or accretion	13.0 acres fill 11- to 15-acre sediment plume lasting ~55 days No significant scour or accretion
Pile and sheet pile removal[a]	Temporary localized increase in SS or turbidity No effects to hydrodynamics	Vibratory pile and sheet pile removal 36 days of activity	Same as Option 1
Screeding	Temporary increase in SS or turbidity	4.9 acres, 2 occurrences	Same as Option 1
Freshwater ice roads[b]	Water withdrawal (water quality or quantity changes) Flow changes from compacted ice on overland ice road	109.9 miles (1,247.3 acres) of onshore ice road 521.2 MG of freshwater	227.9 miles (2,570.1 acres) of onshore ice road 1,004.9 MG of freshwater

Note: ~ (approximately); MG (million gallons); SS (suspended sediment)
[a] No effects anticipated from pile and sheet pile installation since it would occur through bottom-fast ice. No effects to hydrodynamics would occur with piles and sheet piles in place.
[b] No effects anticipated from sea ice road.

The MTI sea ice road would span approximately 2.4 miles through shallow, nearshore areas. Sea ice in the area is typically bottom-fast in water less than 5 feet deep. Areas in which ice was not naturally bottom-fast would be made bottom-fast to construct the ice road by applying sea water on the surface and weighing down the ice. Neither seawater withdrawal nor making ice bottom-fast would affect water quality or coastal processes. Effects of freshwater withdrawal for onshore ice roads are described under Alternative B, above.

After the 5-year design life, armoring and other anthropometric material for the MTI would be removed. The island is expected to be reshaped by waves and ice within 10 to 20 years similar to Resolution and Goose islands, two Beaufort Sea exploratory islands constructed at water depths similar to the Proponent's MTI. Resolution Island is in the Sagavanirktok River Delta and was abandoned in 2003, and Goose Island is in Foggy Island Bay and was abandoned in 1990. The top of these two islands is now at or below the water surface, and their shape resembles natural barrier islands in the Beaufort Sea. The top of the MTI would likely drop to or below the water surface sometime within the 10- to 20-year natural reshaping period. The fines contained by the inner material of the island that had not been winnowed by wave action would likely be resuspended once in contact with the water. Any spills of hazardous material that have been contained by the fill in the island throughout its use may also be released into the coastal waters when the island is reclaimed.

3.8.2.6.2 Option 2: Point Lonely Module Transfer Island

All of the effects to water resources described for Option 1 would apply to Option 2. The main difference is Option 2 would require double the water withdrawal for ice roads (Table 3.8.4), which could cause more effects in lakes used for withdrawal. In addition, the reshaping of the MTI after decommissioning may be faster at Point Lonely than at Atigaru Point because the ambient erosion and sediment transport at Point Lonely is likely higher than at the Sagavanirktok River Delta and Foggy Island Bay, where two historical exploratory islands have been decommissioned. Point Lonely is further north with no land mass to shelter it from longshore transport.

3.8.2.7 Oil Spills and Other Accidental Releases

The EIS evaluates the potential impact of accidental spills. Chapter 4.0 describes the likelihood, types, and sizes of spills that could occur and provides context for spills that have occurred on the North Slope.

Under all action alternatives, spills and other accidental releases could occur. Spills associated with the discharge of oil from leaking wellheads, facility piping, process piping, or aboveground storage tanks would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. These types of spills would be unlikely to negatively affect the tundra or waterbodies adjacent to facilities or structures. Spills not on gravel infrastructure would likely extend to the area immediately adjacent to a facility or structure where the spill occurred.

In the very unlikely event that a reservoir blowout occurs at one of the drill sites (likelihood approaching zero as described in Chapter 4.0), the extent of the accidental release could be much larger, and potentially reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay, due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a). (These low probability, catastrophic events are described in Chapter 4.0.)

Spills originating along pipelines would be expected to be detected and responded to quickly. However, they would potentially have a larger geographic extent than spills on pads. In the very unlikely event that a pipeline spill occurred at a river crossing during high water flow, the extent of the accidental release could be much larger and may reach the channels of Fish Creek (Iqalliqpik or Uvlutuuq) or the Kalikpik River, particularly during periods of flooding. As described in CPAI (2018a), the relatively low flow and highly sinuous nature of streams in the Fish Creek (Iqalliqpik or Uvlutuuq) and Kalikpik River basins may preclude a spill into one of these rivers from reaching Harrison Bay. Pipeline spills would probably not result in changes to the physical hydrology of the area, but the containment and cleanup response to such a spill may result in damage to the tundra, stream banks and channels, or lakeshores and lake bottoms. The extent of the physical hydrology impact would be from the area where the spill occurred downstream along flow paths to a place where the spill was contained or sufficiently dissipated.

The primary effect of an oil spill on water quality would be the toxicity of petroleum hydrocarbons on and reduced dissolved oxygen for aquatic organisms; even small spills of oil into surface water could make water toxic for some aquatic life. Spills into small streams, tundra waters, and ponds would have a greater toxic effect on aquatic plants and animals than spills into larger waterbodies due to the lower relative volume of water and/or flow rate, and would have direct toxic impacts in the water column and the sediments. Long-term toxicity (up to a decade) can result from a small spill (Hobbie 1982) and would be more likely to occur in smaller waterbodies.

Tundra ponds and small, slow-moving waterbodies could have decreases in dissolved oxygen concentrations due to the impermeable nature of the oil slick, which decreases the influx of oxygen from the air, coupled with the high rate of oxygen use by the sediments. These effects are not as likely in flowing water, where dilution of the oil and dispersion of oil slicks would occur before there could be effects on dissolved oxygen concentrations.

Due to the design criteria for pipelines and storage tanks, the limited number of opportunities for spills to reach surface waters, and the monitoring, leak detection, and spill response provisions incorporated into the action alternatives through a Project-specific ODPCP, large spills into water would be unlikely.

Seawater spills over unfrozen waterbodies would increase the salinity and conductivity of the waterbody, which could last for several seasons depending on the size of the spill, the size of the waterbody, and the amount of freshwater input to the waterbody.

3.8.2.7.1 Use and Storage of Hazardous Materials

The Project would require the transport of diesel, gasoline, and other hazardous substances from Alpine to support construction. During operations, hazardous materials would primarily be stored at the WOC, with additional fuel and chemical storage at each drill site as needed. A diesel pipeline would also connect to Kuparuk. Spills of hazardous materials could introduce contaminants directly to surface waters or indirectly to surface or groundwater. However, potential impacts to water resources due to mishandling of hazardous materials would be reduced by the Project's compliance with current state and federal oil pollution and contingency requirements as well as existing BMPs detailed in Section 3.8.2.1, *Applicable Existing Lease Stipulations and Best Management Practices*.

3.8.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Appendix E.8 provides detail about culvert, bridge and pipeline design and how that influences potential effects to water resources. Additional suggested mitigation measures to reduce impacts created by culvert, bridge and pipeline crossings, could include:

1. Unless a more appropriate method is available, when estimating flood-peak discharge at locations within the Fish (Iqalliqpik) Creek, Judy (Iqalliqpik) Creek, and Ublutuoch (Tiŋmiaqsiġvik) River basins, use a weighted average from a single station analysis of the BLM long-term monitoring station data on each of these streams and the Shell regression equations (Appendix E.8). Weight the results of the two computations based on the uncertainty associated with each estimate.
2. As appropriate, consider both 1) snow- and ice-impacted conditions and 2) ice-free conditions in the hydraulic design of bridges, culverts, and pipeline river crossings. Cross-section data at the time of the peak stage and peak discharge that are available for many rivers and streams indicate that the WSE was affected by snow and/or ice blockage. Based on the available information, develop designs that would perform satisfactorily during the design event considering both the possibility of open water conditions and the possibility that snow and ice blockage is occurring at the time of the design event. At a minimum, the

magnitude of the blockage used in the designs should be similar to the magnitude of the blockage that has been observed.

3. At a minimum, design culverts to perform satisfactorily for all flood events up to and including the 50-year event. The headwater to diameter ratio at the maximum design condition should be no greater than 1.0.
4. Identify the locations requiring cross-drainage culverts during spring breakup prior to construction, by noting all locations where water is flowing over the proposed alignment. This is necessary because it is often not possible to determine where water flowing in polygon troughs will cross the alignment during a summer or fall inspection. At the same time, identify the ends of the proposed culverts and the invert elevation of the ends of the culvert in order to maintain the flow in the historic flow path.
5. At a minimum, design road bridges to pass the 50-year flood-peak discharge with a minimum of a 3-foot freeboard (assuming snow and ice conditions have been considered in estimating the design water surface elevation). Design for bridge foundation scour equal to the maximum scour depth produced by floods up through a magnitude equal to the 100-year flood event, and a geotechnical design practice safety factor of from 2 to 3. Check the bridge design using a superflood and a geotechnical design practice safety factor of 1. The superflood is defined as the 500-year event, 1.7 times the magnitude of the 100-year event, or the overtopping flood, whichever is the least. These are standard criteria used by Alaska Department of Transportation and Public Facilities for bridges on the North Slope in non-designated flood hazard areas.
6. At a minimum, design pipeline river-crossings to perform satisfactorily for all floods up to and including the 200-year event (including crossings on bridges or VSM). This is the magnitude of the design event that has typically been used for commercial pipelines on the North Slope and a higher level of design than is being proposed for the Project.
7. Start bridge and culvert hydraulic computations sufficiently downstream so that the downstream boundary assumptions do not affect the performance of the proposed design. Consider the USACE (1986) report “Accuracy of Computed Water Surface Profiles” in determining the location of the downstream boundary for hydraulic computations.
8. If the highest observed WSE or high-water mark is higher than the predicted 50-year WSE at a culvert, bridge or pipeline, re-evaluate the design water surface elevation to confirm that snow and ice blockage, and other details of the computation are accurate. Given the conditions on the North Slope, it is unlikely that high water marks from a 50-year flood or greater would be recognizable unless it occurred in the last 10 to 20 years. Additionally, it is improbable that a 1- to 5-year field program would experience a 50-year flood. It is more likely that snow and ice blockage greater than accounted for in the model used to predict the 50-year WSE or an error in the downstream boundary condition used in the model has occurred.
9. Use a freeboard at bridges and pipeline crossings which considers the uncertainty in the magnitude of the design flood, the uncertainty in the hydraulic computations, and the height of the ice and debris that may be carried by the flood, but is not less than 3 feet.
10. Where an aboveground pipeline crossing is *immediately* upstream from a road, backwater from the road during the pipeline design event should be considered when setting the bottom of pipe elevation. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road wash-out should be considered (i.e., changes in location of the concentrated flow and the impact on erosion at the VSM).
11. Where an aboveground pipeline crossing is immediately downstream from a road, the impact of the road on where water would be flowing and the velocity of the water at the pipeline VSM should be considered. Additionally, if the road is designed for a smaller flood than the pipeline, the changes in hydraulic conditions at the pipeline as a result of the road wash-out should be considered (i.e., changes in the location of the concentrated flow and the impact on erosion at the VSM).
12. Breach ice road crossings sufficiently that ice from crossing would not contribute to ice jams or increase snow and ice blockage during spring breakup.
13. Avoid placing multi-season ice pads in floodplains (e.g., construction pads at the mine site)
14. Prior to HDD construction, provide a monitoring and response plan for determining if drilling mud is being lost to formation or making it to the river or groundwater during drilling.
15. Should any spills occur on the MTI, the affected gravel would be addressed immediately and removed prior to MTI abandonment.
16. Provide annual surveillance of bridge, culvert, and pipeline river crossings to confirm that structures are functioning properly and provide maintenance as required.

3.8.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Implementation of these LSs, BMPs, and mitigation measures would not prevent all impacts to water resources but would prevent irreversible impacts on water quality and quantity. Irretrievable impacts to water quality and quantity would continue for the life of the Project, but those impacts would not impact long-term sustainability of water resources in the analysis areas if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. Water impoundments due to impacts to permafrost (from gravel mining) would be irreversible.

3.9 Wetlands and Vegetation

The analysis area for **wetlands** and vegetation encompasses the watersheds in which wetlands and vegetation would be directly or indirectly affected by the Project (Figure 3.9.1). Watersheds were defined using 10-digit U.S. Geological Survey **Hydrologic Unit Codes** (HUCs). The temporal scale of wetland loss or alteration would span construction to reclamation. If reclamation did not occur, effects to wetlands would be permanent (reclamation is described in Appendix D, *Alternatives Development*). If reclamation did occur, the duration of vegetated wetland recovery after reclamation is expected to be greater than 20 to 30 years, or until more than 50% aerial cover is of the wetland is hydrophytic vegetation, and soils are saturated or inundated for more than 10 days during the growing season (Everett, Murray et al. 1985). The duration of ponded wetland recovery is until inundation has returned. The temporal scale of vegetation damage and soil compaction would span construction to vegetation recovery, expected to be 3 to 5 years post construction (as described below and in Roth et al. [2004]) .

3.9.1 Affected Environment

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3(b)). Wetlands are regulated by Section 404 of the CWA, which requires that the placement of fill in WOUS, including wetlands, is evaluated and authorized by the USACE.

Wetlands are important because they help reduce impacts from flooding, contribute to water quality and quantity, and provide habitat to support plant and animal biodiversity. The largest expanse of arctic fens and thaw lakes in the world is on the ACP (NRC 2003). The lack of subsurface drainage on the ACP is ideal for sedge- and grass-dominated wetlands and waterbodies. Uplands are uncommon because of the high degree of surface inundation (ADF&G 2006).

Approximately 149,112 acres surrounding onshore Project infrastructure in the Willow area was mapped using a combination of the USACE three-parameter method (USACE 1987, 2007) and an ecological unit-based approach. This is referred to as the field-verified portion of the analysis area. Data for this area were derived from multiple years of field data collection and subsequent analysis (Wells, Ives et al. 2018). A complete description of methods used to identify wetlands and vegetation is detailed therein. For the marine area and areas outside the field-verified area, National Wetlands Inventory (NWI) data were used. Field-verified data were used to quantify direct and most indirect impacts (those that are quantifiable) from all onshore action alternatives; NWI data were used to assess the module delivery options and provide context for the relative abundance of wetland and vegetation types in the analysis area. The Project's CWA Section 404 permit process is occurring concurrent with the NEPA process, and though a Jurisdictional Determination has not yet been completed, the EIS analysis assumes that all wetlands and waterbodies described in this section are WOUS and are subject to jurisdiction under the CWA (33 CFR 328.3).

Wetland and vegetation types in the analysis area are detailed in Appendix E.9, *Vegetation and Wetlands Technical Appendix,* and in Figures 3.9.2 and 3.9.3. Table E.9.1 in Appendix E.9 demonstrates that wetland types in the Willow area (the field-verified area) are not unique and occur throughout the analysis area and the ACP.

The field-verified portion of the analysis area is 76% wetlands (Table 3.9.1). Previous disturbance and fill of wetlands in the analysis area is limited to gravel and ice infrastructure from the GMT and Alpine oilfields, the community of Nuiqsut, and decommissioned Distant Early Warning Line sites (Figure 3.9.1). The existing infrastructure and development activities have altered some wetlands' functions, contributed dust and sediment to wetlands, and increased the potential for spills entering wetlands.

Table 3.9.1. Extent of Wetlands in the Field-Verified Portion of the Analysis Area (Acres)

Wetlands	Uplands	Freshwater WOUS	Total
8,420.1	132.7	373.3	**8,957.2**

Note: NA (not applicable); WOUS (Waters of the United States)

There are no plant species listed as threatened or endangered under the ESA known to occur in the analysis area. However, there are three plant species identified as sensitive by the BLM: Eurasian junegrass (*Koeleria asiatica*), false semaphoregrass (*Pleuropogon sabinei*), and Alaskan bluegrass (*Poa hartzii* ssp. *Alaskana*) (Wells, Ives et al. 2018).

Development in the analysis area is minimal, and mechanisms for **invasive species** introduction or transport are limited. Consequently, no invasive plant species have been recorded in the analysis area. The nearest reported invasive species is common dandelion (*Taraxacum officinale*) and foxtail barley (*Hordeum jubatum*), which were recorded along the Tarn Road next to Kuparuk DS2P (McEachen and Maher 2016), approximately 30 miles from the analysis area. Foxtail barley was also recorded approximately 45 miles south near Umiat in 2015 (Alaska Exotic Plant Information Clearinghouse 2018). Large populations of invasive species are common along the Dalton Highway south of Coldfoot (Alaska Exotic Plant Information Clearinghouse 2018), approximately 200 miles from the Project; the high volume of commercial and private vehicle travel there suggests invasive plant seeds are being imported into the region by these means.

3.9.2 Environmental Consequences

3.9.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.9.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate wetland and vegetation impacts from development activity (BLM 2013a). The key activities the LSs and BMPs would help address include impacts to water and vegetation from the construction, drilling, and operation of oil and gas facilities.

Table 3.9.2. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Wetlands and Vegetation

LS or BMP	Description or Objective	Requirement
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from the ordinary high-water mark of fish-bearing waterways.

LS or BMP	Description or Objective	Requirement
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
LS E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration to the land's previous hydrological and vegetative condition.
LS/BMP K-1	(Rivers) Minimize the disruption of natural flow patterns and changes to water quality; as well as the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas.	Permanent oil and gas facilities are prohibited in the streambed and adjacent to the rivers listed, at the distances identified. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	(Deep Water Lakes) Minimize the disruption of natural flow patterns and changes to water quality; as well as the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within one-quarter mile of the ordinary high-water mark.
BMP K-4a	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins.
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; protect summer and winter shoreline habitat; and prevent loss or disturbance of shoreline marshes.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; and maintain populations of, and adequate habitat for birds, fish, and terrestrial mammals.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control
BMP M-3	Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.	Conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there.

Source: BLM 2013a

Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); USGS (U.S. Geological Survey)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect birds would include those to BMPs E-2, E-5, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in BMPs E-2, K-1, and K-2) and freshwater intake pipelines at Lakes M0015 and

R0064 (Figure 3.10.2 in Section 3.10, *Fish*). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also place new VSMs along existing pipeline corridors due to pipe rack capacity limits (deviation to BMP E-5); all alternatives would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip; and under Alternative C, the Willow processing facility would not be colocated with a drill site pad.

3.9.2.2 Alternative A: No Action

Under the Alternative A, seasonal ice roads and pads (and associated water withdrawals) could continue to occur in the analysis area to support oil and gas exploration. Effects from the existing gravel infrastructure in the GMT and Alpine oilfields would continue.

3.9.2.3 Alternative B: Proponent's Project

3.9.2.3.1 Direct Loss and Alteration of wetlands

Project actions that would permanently remove or alter wetlands are placement of gravel fill and gravel mining. Under Alternative B, 429.9 acres of wetlands would be lost due to gravel fill. Another 30.0 acres of multi-season ice pads (lasting more than 1 full year in a single location) would be considered temporary fill under the CWA and would be subject to USACE jurisdiction. Effects would be similar to those of ice infrastructure and thus are discussed with that topic in the EIS (in Section 3.9.2.3.2, *Direct Vegetation Damage and Soil Compaction*). Tables E.9.2 and E.9.3 in Appendix E.9 detail the types of wetlands that would be filled by action alternative. The direct fill would occur in no more than 0.2% of any of the five (10-digit) HUCs in which the fill would occur. Schueler et al. (2009) reported a correlation between the increase of impervious cover and a decrease in various watershed functions based on wetland and waterbody characteristics (geomorphology, habitat, water quality, water level fluctuation in wetlands, **benthic** macroinvertebrates, and fish). For the EIS analysis, impervious cover was used as a proxy for gravel fill since both impervious cover and gravel fill decrease the infiltration rate of precipitation and increase surface runoff in a watershed. Wetland conditions in watersheds with less than 5% cover by impervious surfaces are good (i.e., close to reference conditions, which were defined as the average condition of the three least impaired wetlands; Hicks and Larson 1997). Wetland conditions in watersheds with more than 20% cover by impervious surfaces were moderately to severely impaired.

Approximately 229.6 acres of wetlands would be permanently altered due to gravel mining. A mine site reclamation plan would coordinate with agencies prior to the start of mining. Regardless of specific details for reclamation (e.g., if the pits would be connected to streams), the pits would fill with water (from ground or surface water, or from permafrost melt) and thus existing wetlands (detailed in Table E.9.4 in Appendix E.9) would be altered to be **lacustrine**. Work in wetlands would be minimized to the extent possible; however, because of the prevalence of wetlands in the analysis area, some fill or excavation would occur in wetlands.

3.9.2.3.2 Direct Vegetation Damage and Soil Compaction

Project actions that would damage vegetation or compact soils are construction of ice infrastructure and off-road travel.

Ice infrastructure would potentially damage vegetation by freezing plant tissues, physically damaging plant structures, and causing stress that delays plant development. Delayed plant development can modify vegetation (decrease plant size and cover) in the long term and lead to visible traces on the tundra surface (Guyer and Keating 2005). Effects from ice roads are amplified by repeated use of the same route over multiple seasons (Yokel, Huebner et al. 2007). Ice pads used for multiple seasons allow less time during the growing season for vegetation to recover. The degree of saturation is a key factor in mitigating effects from ice infrastructure; ice roads that cross wetter vegetation result in fewer effects than ice roads that cross drier vegetation (Felix and Raynolds 1989; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014). Flooded and wet tundra wetlands generally exhibit few or no effects from ice road construction (Felix and Raynolds 1989; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014), while some areas of moist tundra still show signs of disturbance after 12 years (Yokel and Ver Hoef 2014). Flooded and wet tundra wetlands freeze to the surface before the ice road season begins, protecting underlying vegetation. Moist tundra would likely show signs of disturbance after 12 years of the last multi-season ice road being built. Effects on sensitive vegetation would be mitigated by using BMPs for routing and constructing ice roads, in accordance with NSB requirements (NSB Code 19.50.030(J), and 19.60.040(O)).

Approximately 2,872.3 acres of vegetation damage could occur from ice infrastructure for Alternative B. Of those acres of vegetation damage, 30.0 acres would be from multi-season ice pads and could have a longer duration of effects than single-season ice infrastructure. Damage would occur over no more than 1.2% of any of the 11 HUCs in which the effect would occur (Table E.9.5 in Appendix E.9).

Effects on soil are not as severe as they are on plants. Typically, little change in the soil thaw depth and compaction of soil result from ice road construction (BLM 2012b; Walker and Everett 1987; Yokel, Huebner et al. 2007; Yokel and Ver Hoef 2014).

Off-road travel would likely occur in rare instances during emergencies (i.e., vehicle overturns off embankment). Effects to vegetation and soil from off-road travel vary by season of travel and the size of the vehicle. Off-road travel in the winter by any size vehicle can directly affect shrubs such as diamond-leaf willow (*Salix pulchra*), which have a substantial proportion of branches and live tissue remaining above the snow that can be broken. The degree of effects depends on 1) the wetland class, 2) the degree to which the wetland is inundated, 3) the number of passes by the off-road vehicle, and 4) the size/type of the vehicle. Off-road travel in winter on drier tundra is more likely to damage wetlands than travel on flooded tundra because of soil compaction and root wad disturbance.

Winter off-road travel would be expected to result in low to moderate disturbances of tundra vegetation, which would recover within 3 to 5 years. As defined in Roth et al. (2004), low tundra disturbance due to off-road travel is a <25% decrease in vegetation or shrub cover and <5% exposed soil visible, where the vehicle trail is evident only within its tracks. Moderate tundra disturbance is a 25% to 50% decrease in vegetation or shrub cover and/or 5% to 15% exposed soil visible, where the vehicle trail may appear wetter than the surrounding area.

Areas effected by off-road vehicles in the summer typically recover to near original state within 10 years or less on the North Slope, if the organic mat (the upper layer of plant material in which plants grow and form a mat of roots above mineral soil) remains unbroken (Abele, Brown et al. 1984). Unlike winter off-road travel, summer off-road travel compacts saturated soils in wet tundra more than in dry tundra. In general, recovery begins approximately 3 years after the initial traffic impact (Abele, Brown et al. 1984).

3.9.2.3.3 Indirect Change in Wetland Composition

Project actions that could change wetland composition are construction and use of gravel infrastructure, and water withdrawals. Several things could contribute to changes in wetland composition: changes in soil composition, changes in vegetation patterns, changes in local hydrologic systems, and increased mechanisms for introduction or dispersal of invasive species. Each of these effects is discussed below. Effects would generally occur close to gravel fill, potentially both up and downgradient of the fill (described below).

Dust and gravel spray would be generated during gravel placement and compaction, snow clearing, vehicle traffic, and equipment operations on gravel roads and pads. Dust control measures would be implemented to reduce deposition of dust on vegetation or snow and to minimize impacts to WOUS. Even with dust control measures in place, dust from traffic throughout the life of the Project would accumulate adjacent to roads and pads. The area of deposition by airborne dust is called the dust shadow. Within the shadow, deposited dust overlays and potentially smothers vegetation before eventually being incorporated into the native soil and altering the soil composition. Road dust has the greatest effect within 35 feet of a road, but deposition may occur over a broader area. Roughly 95% of dust settles within 328 feet (100 m) from a road surface (Myers-Smith, Arnesenm et al. 2006; Walker and Everett 1987).

Dust deposited on snow drifts decreases their albedo, leading to earlier melting (Auerbach, Walker et al. 1997; Klinger, Walker et al. 1983) and increased local soil moisture levels in the spring (Brown, Brockett et al. 1984), which can result in early green-up (Walker and Everett 1987). Dust shadows typically decrease nutrient levels in soils (Auerbach, Walker et al. 1997), decrease soil moisture, increase thaw depth, alter the active layer (the upper layer of soil that is churned through the freeze-thaw cycle), and contribute to thermokarst development (Auerbach, Walker et al. 1997; Walker and Everett 1987). Thermokarsting results from thawing of near-surface ice and may be accelerated by loss of vegetation cover due to dust deposition, impoundments, or early snowmelt from changes in surface albedo.

Alternative B would create a dust shadow over 3,155.1 acres of wetlands. Tables E.9.6 and E.9.7 in Appendix E.9 details effects by wetland type and watershed. The dust shadow would occur in no more than 1.2% of any of the six HUCs in which the effects would occur.

The physical and chemical effects from dust deposition on tundra from gravel infrastructure may reduce photosynthesis or change the soil pH and thus could cause vegetation mortality (Walker 1987) or a reduction in vegetation biomass (Auerbach, Walker et al. 1997). Additionally, the change in albedo from the dust shadow could result in the early green-up of plants (Walker 1987), increased grass and sedge composition (Auerbach, Walker et al. 1997), and decreased sphagnum and other mosses and lichens (Everett 1980; Walker 1987) close to gravel infrastructure.

Snow accumulations downwind of the raised roads and pads would insulate soils, lessening changes in winter soil temperature, and could increase standing water as the snow melts in late spring or early summer. This could cause subsidence adjacent to gravel fill. Plowing may cause increased snowdrift accumulation on the downwind side of roads, as well as adjacent to roads and pads due to blocked wind-swept snow. Although snowbanks adjacent to gravel roads with heavy winter traffic may be several times deeper than the average snowpack from drifting or plowing, these areas are often the first areas to melt, due to the albedo effect of dust on snow (Klinger, Walker et al. 1983). The deeper snow depth restricts the seasonal frost penetration and the earlier thaw increases heat absorption, which results in a compounding effect of a deeper active layer.

Gravel infrastructure and culverts could alter surface flow and result in ponded water upgradient of the structure (Section 3.8, *Water Resources*); this could induce subsidence, particularly as permafrost temperatures increase with climate change. An increase in water impoundments could delay plant growth or contribute to conversion of vegetated tundra to lakes if the impoundments become permanent (Jorgenson and Joyce 1994). Increased surface water depth and duration of inundation on the upgradient side of gravel fill areas could transform the vegetation community composition into wetter tundra types and thus increase grass and sedge cover and decrease shrub cover. It could also lead to plant mortality if the increased inundation becomes permanent and a potential waterbody is created (Walker 1987). During spring snowmelt, impoundments could occur on the upgradient side of gravel fill, and natural drainage patterns could be interrupted on the downgradient side of fill. The effects may include decreased soil moisture and subsequent changes in vegetation communities, such as an increase in shrub cover and a decrease in grass and sedge cover, as well as conversion from a wetland to upland.

Water withdrawals from lakes also may indirectly affect adjacent wetlands by reducing the amount of water available to the wetland community. However, if sufficient recharge occurs in the spring, there would be no effects to wetlands and waterbodies.

The Project would increase mechanisms for invasive species introduction or dispersal to the Project area. Invasive plant species would most likely be introduced to the ACP through the Dalton Highway and airports and then be dispersed by vehicle traffic (Ansong and Pickering 2013). Established invasive species could alter existing wetland types and functions.

3.9.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences. Alternative C would have 48.7 more acres of wetland loss, since there would be a second airstrip and camp located near BT1 or BT2 (Tables E.9.2 through E.9.7 in Appendix E.9). Alternative C would also require an annual ice road (3.9 miles) that could be constructed in the same footprint in consecutive years throughout the life of the Project, which would increase the duration and severity of vegetation damage and soil compaction, and impact 528.0 more acres of wetlands than Alternative B. Alternative C would have one fewer bridge crossing, thus 2.3 fewer acres of riverine wetlands and other WOUS would be impacted.

3.9.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described under Alternative B, with the following differences. Alternative D would have 32.0 fewer acres of wetland loss (Tables E.9.2 through E.9.7 in Appendix E.9). However, Alternative D would also require an annual ice road (9.8 miles) that could be constructed in the same footprint in consecutive years throughout the life of the Project, which would increase the duration and severity of vegetation damage and soil compaction; 1,578.9 more acres of wetlands would be impacted by ice infrastructure than Alternative B. Alternative D would have one fewer bridge crossing than Alternative B, but would have the same number of impacts to riverine wetlands and other WOUS (6.9 acres total). Alternative D would have the 4.2 acres less of multi-season ice pad impacts than Alternative B because the multi-season ice pad at the WOC would overlap with the WOC gravel pad.

3.9.2.6 Module Delivery Options

Both module delivery options would use ice roads; effects of ice roads are described under Alternative B, and differences in ice road acres are described below.

3.9.2.6.1 Option 1: Proponent's Module Transfer Island
Option 1 would have 1,355.3 acres of ice roads and ice pads that could damage vegetation and compact soil (Table E.9.8 in Appendix E.9). Option 1 would have 30.0 acres of multi-season ice pads. Option 1 would also fill 12.8 acres of marine WOUS, approximately 2.4 miles offshore of Atigaru Point. Though the MTI would be decommissioned within 5 years of construction, fill would not be removed. The island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.5.1, *Option 1:* Proponent's *Module Transfer Island,* in Section 3.8, *Water Resources*).

3.9.2.6.2 Option 2: Point Lonely Module Transfer Island
Option 2 would have 1,397.9 more acres of ice infrastructure that could damage vegetation and compact soil than Option 1 (Table E.9.8 in Appendix E.9). Option 2 would also fill 13.0 acres of marine WOUS, approximately 0.6 mile offshore of Point Lonely, and have the same decommissioning methods and effects as Option 1. Option 2 would have the same number of acres of multi-season ice pads (30.0 acres) as Option 1.

3.9.2.7 Spills and Other Accidental Releases
Although oil spills and other accidental releases are not a planned activity of the Project under any alternative, effects to water resources should a spill occur are discussed here. Chapter 4.0, *Spill Risk Assessment,* describes the likelihood, types, and sizes of spills that could occur and provides context for spills that have occurred on the North Slope.

Under all action alternatives, spills and other accidental releases could occur. Spills associated with the discharge of oil from leaking wellheads, facility piping, process piping, or aboveground storage tanks would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. These types of spills would be unlikely to negatively affect the tundra or waterbodies adjacent to facilities or structures. Spills not on gravel infrastructure would likely extend to the area immediately adjacent to a facility or structure where the spill occurred and could result in direct mortality of vegetation.

In the very unlikely event that a reservoir blowout occurred at one of the drill sites (likelihood approaching zero as described in Chapter 4.0), the extent of the accidental release could be much larger and could distribute an aerial mist of oil over tundra vegetation as described in Chapter 4.0. A blowout could reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay, due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

Effects of potential spills on wetlands and vegetation would vary by season, vegetation type, and substance spilled. Winter spills would have a lesser effect because cleanup is easier (NRC 2003). Oil, diesel fuel, and seawater spills on nonfrozen plants or soil would have effects that could potentially last many years. Even a moderate concentration of oil (about 12 liters per square meter) is enough to kill most plant species (Walker 1987). Saltwater spills can be toxic to many plant species, long lasting, and can cause physiological stress, including leaf deterioration and deleafing (Simmons 1983). Documented effects to vegetation have varied by plant species and by the hydrology of a particular site: wetter sites recover more rapidly and show less stress. Willow species (*Salix* spp.) and mountain avens (*Geum* spp.) have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.9.3 Additional Suggested Best Management Practices or Mitigation
All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Additional suggested mitigation measures to reduce wetland and vegetation impacts could include:

1. Monitor vegetation damage, and compression of soil and vegetation in annual resupply ice road footprint (footprints that are used consecutively each year).
2. Provide stations to clean footwear and gear so they are free from soils, seeds, and plant parts.
3. Provide training to employees and contractors in identification, control, and prevention of known invasive plant species.
4. Restrict use of heavy equipment in summer to pads (established BMPs here: http://www.nae.usace.army.mil/ Portals/74/docs/regulatory/StateGeneralPermits/MA/ConstructionMatBMPs.pdf).

5. Confine loading and unloading of soils for gravel stockpiles to the downwind side of the pile; if piles would be on-site for longer periods of time, seed with appropriate vegetation to reduce wind erosion. Wind barriers (such as snow fences) may also be appropriate in some situations.

3.9.4 Unavoidable Adverse, Irretrievable, and Irreversible Effects

Some loss of wetlands and vegetation would be unavoidable. The function associated with those wetlands would be irretrievably lost throughout the life of the Project until reclamation is complete. If reclamation did not occur, including the removal of gravel fill, the loss would be irreversible. The loss would not be irreversible if reclamation occurred, which would also prevent impacts to the long-term sustainability of wetland function in the fill footprint.

3.10 Fish

The analysis area for fish and essential fish habitat (EFH) includes aquatic habitats adjacent to and downstream of Project infrastructure and nearshore marine waters off Atigaru Point and Point Lonely in the southern Beaufort Sea (Figure 3.10.1). The main freshwater drainages in the Willow area are the Kalikpik River, Fish (Uvlutuuq) Creek, Fish (Iqalliqpik), Judy (Iqalliqpik) Creek, Judy (Kayyaaq) Creek, the Ublutuoch (Tiŋmiaqsiuġvik) River, and several smaller tributaries and aquatic habitats. The temporal scale for construction-related impacts is the duration of construction activities. The temporal scale for operational impacts is the life of the Project, or until reclamation is complete. Reclamation of onshore areas can take many years, depending on the tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. Marine substrates that would be screeded are expected to return to pre-screeding condition in approximately one season. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.5.1, *Option 1:* Proponent's *Module Transfer Island,* in Section 3.8, *Water Resources*).

3.10.1 Affected Environment

Freshwater fish habitat in the Willow area is generally representative of habitats across the ACP. Streams are generally low gradient and slow moving with unstable banks, and substrates dominated by sand and silt and isolated areas of gravel (CPAI 2018a). Aside from the major stream corridors, a complex network of lakes and small streams dominates the aquatic habitat. Habitat suitable to support fish during winter is limited. Streams that would intersect the Project are shallow and likely freeze to the bottom during winter. Surface water typically freezes during September and thaws in late May to June. Peak annual flow is from snowmelt during spring breakup, when large expanses across the ACP become inundated by water. Summer flows typically decline, with some streams becoming intermittent by mid- to late summer. Flows often increase in late summer due to rain events, which allows fish a final opportunity to move to wintering areas. Surface flow connectivity is needed for fish to access important rearing, feeding, spawning, and overwintering habitats. As described in Appendix E.8, *Water Resources Technical Appendix,* climate change is occurring, and precipitation levels are projected to increase. A concurrent increase in evapotranspiration may result in a net loss in surface water by the end of the summer. Increases in winter precipitation may affect lake recharge and peak snowmelt runoff in rivers and streams.

Existing development and infrastructure in the analysis area is limited. Some seasonal ice infrastructure and associated water withdrawal occur annually to support oil and gas exploration. Some gravel infrastructure from the GMT and Alpine oilfields exists in the lower reaches of the Ublutuoch (Tiŋmiaqsiuġvik) and Fish (Iqalliqpik) Creek basins (Figure 3.10.1). This existing gravel infrastructure and development activities (traffic, drilling, processing, etc.) contribute dust, sediment, noise, and the potential for spills to surrounding waterbodies. No marine infrastructure exists in the analysis area. The freshwater and marine areas are used for subsistence and research and have a relatively minor amount of associated boat, foot, air, and off-road vehicle traffic.

Fish are widely distributed throughout the network of lakes, ponds, alluvial and beaded streams, and adjacent wetlands. Most common fish species are Arctic grayling (*Thymallus arcticus)*, broad whitefish (*Coregonus nasus)*, least cisco (*Coregonus sardinella)*, Arctic cisco (*Coregonus autumnalis)*, Arctic flounder (*Liopsetta glacialis)*, round whitefish (*Prosopium cylindraceum)*, humpback whitefish (*Coregonus pidschian)*, and ninespine stickleback (*Pungitius pungitius)*. A comprehensive list of the 24 fish species documented in the analysis area and their life history characteristics is provided in Appendix E.10, *Fish Technical Appendix*.

Many of these species, particularly **anadromous** species, migrate both locally and extensively between major drainages to access habitats that support various life history stages (Heim, Wipfli et al. 2015; McFarland, Morris et al. 2017a; Morris 2003). Abundant stream-lake networks are often seasonally accessible, yet provide important and complex habitats for multiple species of fish (Heim, Arp et al. 2019). Seasonal waterbody connectivity and flow regimes influence habitat accessibility and use (Heim 2014). Shallow, nearshore marine habitats are used by multiple age classes of forage fish and provide rearing and foraging habitats for other fish species and life stages (Johnson, Thedinga et al. 2010; Logerwell, Busby et al. 2015).

3.10.1.1 Essential Fish Habitat

Approximately 240 miles of stream habitat in the Fish (Uvlutuuq and Iqalliqpik) Creek basin, including portions of the Ublutuoch (Tiŋmiaqsiġvik) River, and Judy (Kayyaaq and Iqalliqpik) Creek, are designated as EFH for pink (*Oncorhynchus gorbuscha*) and chum salmon (*Oncorhynchus keta*) and 217 miles are designated for Chinook salmon (*Oncorhynchus tshawytscha,* Figure 3.10.2) (Johnson and Blossom 2017; North Pacific Fishery Management Council 2009, 2012). EFH for chum and sockeye salmon (*Oncorhynchus nerka*) was identified in field studies in 2017 and 2018 in the Willow area. Chum salmon were identified in Judy (Kayyaaq) Creek, a tributary of Judy (Iqalliqpik) Creek. Willow Creek 4, another tributary of Judy (Iqalliqpik) Creek, was used by chum and sockeye salmon in both years (McFarland, Morris et al. 2017a; McFarland, Wipfli et al. 2017). Nearshore estuarine and marine waters of the Beaufort Sea are designated as EFH for all five Pacific salmon species and arctic cod (*Boreogadus saida*) (North Pacific Fishery Management Council 2009, 2012). Marine EFH for Pacific salmon is limited because only chum and pink salmon are distributed extensively in ACP streams. Coho salmon (*Oncorhynchus kisutch*) have never been identified in the area, while Chinook and sockeye salmon distribution is restricted to low numbers of individuals in a few drainages within the analysis area.

3.10.2 Environmental Consequences

3.10.2.1 Applicable Existing Lease Stipulations and Best Management

Table 3.10.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate impacts to fish from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to fish habitat, subsistence hunting and fishing areas, and the environment, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.10.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended Mitigate Impacts to Fish

LS or BMP	Description or Objective	Requirement
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP B-1	Maintain populations of, and adequate habitat for, fish and invertebrates.	Withdrawal of unfrozen water from rivers and streams during winter is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.

LS or BMP	Description or Objective	Requirement
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach.
BMP C-4	Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.	Travel up and down streambeds is prohibited unless demonstrated that there will be no additional impacts to over-wintering fish or the invertebrates they rely on.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Protect fish-bearing water bodies, water quality, and aquatic habitats.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.
BMP E-4	Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.	All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-14	Ensure the passage of fish at stream crossings.	To ensure that crossings provide for fish passage, all proposed crossing designs shall collect at least 3 years of hydrologic and fish data.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Land used for oil and gas infrastructure shall be reclaimed to ensure restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM. The plan shall describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the land's previous hydrological, vegetative, and habitat condition.
LS/BMP K-1	For rivers, minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; and the disruption of subsistence activities.	Permanent oil and gas facilities are prohibited in the streambed and adjacent to the rivers listed, at the distances identified. Fish (Uvlutuuq) Creek: 3-mile setback Judy Creek (Kayyaaq and Iqalliqpik channels): ½-mile setback Ublutuoch (Tiŋmiaqsiugvik) River: ½-mile setback

LS or BMP	Description or Objective	Requirement
LS/BMP K-2	For deep water lakes, minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes; the loss of spawning, rearing or over wintering habitat for fish; and the disruption of subsistence activities.	Permanent oil and gas facilities are prohibited on the lake or lakebed and within one-quarter mile of the ordinary high-water mark of lakes deeper than 13 feet.
LS/BMP K-6	For coastal areas, protect coastal waters and their value as fish and wildlife habitat, prevent alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; maintain populations of, and adequate habitat for birds, fish, and caribou; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulations)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect fish would include those to LS E-2 and BMPs E-11, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1 and K-2) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody.

3.10.2.2 Alternative A: No Action

Under the No Action Alternative, ice infrastructure and associated water withdrawals in the analysis area could continue to occur to support oil and gas exploration. Effects from the existing gravel infrastructure in the Alpine and GMT oilfields would continue.

3.10.2.3 Alternative B: Proponent's Project

3.10.2.3.1 Habitat Loss, Alteration, or Creation

Project activities that may remove, alter, or create fish habitat are as follows:

- New gravel roads, gravel pads, airstrips, VSMs, culverts, bridges, and water intake structures
- Gravel mining and mine site reclamation
- Vehicle traffic on gravel infrastructure
- Ice infrastructure within or crossing waterbodies or floodplains

Gravel fill would permanently remove freshwater aquatic habitat within the footprint of VSMs, bridge abutments, piles, and stream crossings (7 bridges and 11 culvert batteries). Roads would avoid crossing known overwintering fish habitat (Figure 3.10.2). Several pads would also place fill in lakes (Table E.10.2 in Appendix E.10).

Bridge piles in waterbodies could remove habitat in the pile footprint and potentially cause scour around the piles. Alternative B would have 56 piles below OHW: 52 would occur in anadromous streams (also designated as EFH), and 4 would occur in a stream with only resident fish. All stream crossings would be designed to provide season-long fish passage in accordance with all ADF&G requirements. No culverts would occur on streams with documented anadromous fish use. Proper culvert sizing, maintenance, and placement relative to seasonal flows would ensure passage for non-anadromous fish during important migration periods in spring and fall and maintain natural hydrogeomorphic processes and drainage patterns during operations.

Gravel excavation at the mine site would occur within 266 feet of Bills Creek and within 310 feet of the Ublutuoch (Tiŋmiaqsiġvik) River. Both of these streams provide high-use habitat for resident and anadromous fish; the Ublutuoch (Tiŋmiaqsiġvik) River provides overwintering habitat in a limited reach of the river, which is approximately 3+ miles downstream of the mine site. Because blasting and gravel excavation would occur in winter, when surrounding aquatic habitats are frozen bottom-fast, fish habitat would not be affected. Once mining is complete, the Mine Site could be connected to adjacent streams and allowed to fill with water. If the pit is connected, water depths would likely exceed 7 feet and would create up to 230 acres of new overwintering habitat for fish (a naturally rare habitat type in the Project area). Mine site design and reclamation would be developed in consultation with the State and NSB and would include guidelines to maximize the potential for productive fish habitat (Joyce, Rundquist et al. 1980; McLean 1993; Ott, Winters et al. 2014).

Increased sedimentation could occur from unplanned surface water connections to the mine pit either during spring floods or once the site fills with meltwater (Joyce, Rundquist et al. 1980). Temporary alterations to freshwater habitat could also be caused by increased sedimentation from runoff associated with gravel and ice infrastructure. Effects would be temporary and limited to localized areas surrounding the infrastructure. Sediment mitigation measures would be employed, such as SWPPPs and existing BMPs, to limit pad and road run-off to fish habitat.

Dust deposition from vehicle traffic on gravel roads throughout the life of the project could alter 4.1 acres of lake habitat that supports **sensitive fish**, and 13.6 acres of lake habitat with unknown fish presence (Table E.10.2 in Appendix E.10). The dust shadow (the area within 328 feet [100 m] of gravel roads and pads) is detailed in Section 3.4 (*Soils, Permafrost, and Gravel Resources*). Even with dust control measures in place, dust deposition would still occur.

Ice roads and pads can also alter fish habitat by temporarily blocking passage or eroding streambeds or stream banks. Fish passage can be blocked when compacted ice, which takes longer to melt, remains bedfast and channel-wide at stream crossings in the spring. Arctic fish populations rely on, and move between, multiple habitats throughout the year (Heim, Arp et al. 2019). These populations have a restricted growth season and are often limited by suitable wintering habitat. Thus, maintaining passage during spring and late fall when fish naturally move from wintering habitat to preferred spawning or feeding habitats is important for maintaining productive fish populations. Ice infrastructure over defined stream channels would be removed, breached, and/or slotted before spring breakup to allow flow connectivity, minimize blocked passage, and minimize the potential for stream bank or streambed erosion (as per BMP C-3). Techniques to properly breach and slot ice bridges vary depending on the physical habitat and hydrologic conditions at each site. Improper slotting techniques can alter hydrologic conditions and erode stream banks, which can adversely affect habitat quality and interrupt natural fish movement. Alternative B would have 372.0 miles of ice roads. While individual fish may be affected by ice infrastructure, impacts would not result in population level effects. Effects from blocked passage and erosion would last through spring breakup, which usually occurs in early June. In extreme and unlikely cases, longer lasting impacts on a local spawning population could occur if blockages caused substantial delays to migrating Arctic grayling during the spring spawning period and reduced fry production from that specific creek. Blocked passage could also affect whitefish species attempting to move upstream in spring and delay or prohibit them from reaching preferred feeding areas. Deposition could also occur at eroded locations if flow is restricted long enough to encounter thawed soils. Effects from ice infrastructure would be geographically limited to specific stream crossing locations and a stream-specific spawning population of fish.

Water withdrawal for ice infrastructure can alter fish habitat by reducing the quantity of water available for fish and changing water-quality parameters such as dissolved oxygen, pH, and conductivity. Habitat alterations in withdrawal lakes would be temporary and would last until spring breakup, when lakes recharge. Water withdrawal would follow existing BMP B-2, as well as ADNR and ADF&G permit stipulations, which limit water removal during winter based on whether fish species sensitive to, or resistant to, the potential effects of water withdrawal are present. Sensitive fish are susceptible to changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, whereas **resistant fish** are more resilient to these conditions. Resistant fish are ninespine stickleback and Alaska blackfish (*Dallia pectoralis*), while all other species (e.g., broad whitefish, least cisco, Arctic grayling) are sensitive. Alaska blackfish are particularly resistant to low dissolved oxygen and are able to use atmospheric oxygen to survive (Armstrong 1994). Ninespine stickleback can also withstand low dissolved oxygen (Lewis, Walkey et al. 1972), although not to the same extent as Alaska blackfish. However, ninespine stickleback can withstand higher levels of dissolved solids, and often frequent brackish nearshore waters during summer.

Under Alternative B, 1,874.0 MG from an unknown number of lakes would be withdrawn over the life of the Project for ice infrastructure, construction, domestic use, and dust suppression. Although individual fish may be affected, water withdrawal using existing BMPs and permit stipulations would not cause population-level effects.

3.10.2.3.2 Disturbance or Displacement

Disturbance or displacement of aquatic species is only anticipated to occur at stream crossings when water is flowing, and vehicle traffic is present. Fish would be temporarily displaced in the immediate area of the stream crossing, which is a fraction of the available similar quality habitat throughout the analysis area. Localized temporary displacement could occur throughout Project operations.

Construction at freshwater stream crossings would occur in winter, when most tundra streams, shallow ponds, and lakes are frozen to the substrate. The Project would avoid crossing known overwintering freshwater fish habitats; thus, fish would not be present at any of the stream crossings during construction.

Winter gravel excavation at the new mine site would occur within 266 feet of Bills Creek and within 310 feet of the Ublutuoch (Tiŋmiaqsiġvik) River, both anadromous streams that would be frozen to their beds during mining activities. The closest overwintering habitat for fish is located in the lower Ublutuoch (Tiŋmiaqsiġvik) approximately 3+ miles from the blast sites; thus, fish would not be affected by blasting or gravel excavation.

3.10.2.3.3 Injury or Mortality

Fill in streams or lakes associated with culverts or pads placed during the open-water season could impact individual fish by burying them in the fill footprint. Effects would be limited to the fill footprint and would occur one time during gravel placement. The open-water season is the only time when steel plate culverts used for fish passage can be placed, due to the need to achieve adequate gravel compaction around them for structural support. If these are needed, ADF&G open-water work windows would be followed.

3.10.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences: there would be 1 less bridge, 1 less culvert battery, and 20 fewer piles below OHW. There would be 1 additional season of ice roads and water withdrawal during construction as well as an annual ice road (3.9 miles) required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative C would have 99.0 more miles of ice road over the life of the project and use 173.2 MG more freshwater (2,047.2 MG total). Appendix E.10 provides a comparison of Project components that affect fish by alternative.

3.10.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be the same as described under Alternative B, with the following differences: there would be 1 less bridge, 3 fewer culvert batteries, and 4 fewer piles below OHW. There would be 2 additional seasons of ice roads and water withdrawal during construction as well as an annual ice road (9.8 miles) required for the life of the Project, which could have longer lasting effects on water withdrawal lakes. Alternative D would have 322.5 more miles of ice road over the life of the Project and use 559.8 MG more freshwater (2,433.8 MG total). Appendix E.10 provides a comparison of Project components that affect fish by alternative.

3.10.2.6 Module Delivery Options

Effects to fish and fish habitat from module delivery options are summarized in Table 3.10.2.

Option 1: Proponent's Module Transfer Island

Gravel fill for the MTI would permanently remove 12.8 acres of nearshore marine EFH for Arctic cod and Pacific salmon in approximately 8 to 10 feet water depth. The MTI area currently has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). The MTI would alter existing substrates by adding gravel and gravel bags. The MTI would be decommissioned after construction and the gravel would be naturally redistributed by wind and waves, which would alter the substrate of surrounding habitats. Fish and benthic surveys conducted in the MTI and sea ice road area suggest a relatively low complexity and low productivity natural condition that would likely recover within a few seasons after reclamation (Kinnetic Laboratories Inc. 2018). Construction and reclamation of the MTI is not anticipated to impede fish migration.

Screeding would temporarily alter benthic marine habitat by recontouring sediments prior to barge landings. Because substrate types would not change and the screeded ground would likely resettle to conditions similar to those prior to screeding, this is unlikely to affect fish habitat.

Table 3.10.2. Effects to Fish and Fish Habitat from Module Delivery Options

Project Component	Effect to Fish or Fish Habitat	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Gravel fill in marine area	Habitat and EFH loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise during gravel recontouring in summer	12.8 acres lost 11 to 15 acres altered 125 dB rms at 328 feet from the source	13.0 acres lost 11 to 15 acres altered 125 dB rms at 328 feet from the source
Pile and sheet pile removal[a]	Disturbance or displacement from noise	129 dB at 328 feet from the source[b] 36 days of activity; 9 pipe piles 685 (30 to 40 foot) sheet piles	Same as Option 1
Screeding	Temporary habitat alteration Disturbance or displacement from noise or human activity Injury or mortality of benthic species	4.9 acres altered, 2 occurrences 164 to 179 dB rms at 3.28 feet Minimal injury of fish entrained in screeded material	Same as Option 1
Freshwater ice roads	Habitat alteration from water withdrawal (water quality or quantity changes) Habitat alteration from temporarily blocked passage	521.2 million gallons of water 109.9 miles of onshore ice road 1,355.3 acres of onshore ice roads and ice pads	1,004.9 million gallons of water 227.9 miles of onshore ice road 2,753.2 acres of onshore ice roads and ice pads
Barge traffic	Disturbance or displacement from noise and human activity	Temporary disturbance along nearshore barge route ~600 more miles of sealift barge traffic[c] 145 to 175 dB rms at 3.28 feet from the source	Temporary disturbance along nearshore barge route ~22,400 more miles of support vessel traffic[c] 145 to 175 dB rms at 3.28 feet from the source

Note: dB (decibels), EFH (Essential Fish Habitat), MTI (module transfer island), rms (root mean square). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*.
a No underwater noise anticipated from pile and sheet pile installation since piles would be driven through grounded ice.
b Pangerc et al 2017
c Both options would have the same number of trips, but distance traveled would vary by option. Atigaru Point is approximately 50 miles from Point Lonely. Six round-trip barge trips over that distance is 600 miles. Barges would travel from southern Alaska. Support vessels would originate at Oliktok Point; 224 round-trip support vessel trips over 50 miles is 22,400 miles.

During the summer construction season, 11 to 15 acres of nearshore marine fish habitat would be temporarily altered due to increased suspended solids and turbidity (Coastal Frontiers Corporation 2018b). This could occur due to mobilization of fine-grained material in the MTI fill into the water column or from in-water work (screeding or recontouring of the MTI slopes). Effects would be temporary and localized because the disturbance plume would quickly settle and therefore would not affect fish at the population level. The duration of the plume would depend on the amount of fines in the fill and could last 0.5 hour to 55 days (Coastal Frontiers Corporation 2018b).

Based on data for western Harrison Bay, current speeds are too low to cause significant, permanent scour of the sea bottom surrounding the MTI (Coastal Frontiers Corporation 2018a). Average rates of shoaling in the area are low (CPAI 2019a). Other human-made islands in the Beaufort Sea experience small amounts of shoaling on the leeward side. Similar amounts would be expected at the MTI and would not affect the stability of the MTI or coastal processes around it. No accretion or further shallowing of the MTI area would be expected to occur.

The MTI sea ice road would span approximately 2.4 miles through shallow, nearshore EFH, which would be naturally grounded and therefore would not affect fish or fish habitat. Once onshore, the freshwater ice road would be approximately 109.9 miles (total); effects of ice roads (temporary habitat alteration) are described above under Alternative B.

In-water work for the MTI would be limited to screeding, contouring the fill, and, eventually, pile removal (during reclamation), which could disturb or displace fish due to noise and human activity (Hastings and Popper 2005; Ruggerone, Goodman et al. 2008). The underwater ambient sound level in the Beaufort Sea is approximately 120 decibels (dB) re 1 micropascal (µPa); the marine underwater acoustic environment is characterized in Appendix E.13, *Marine Mammals Technical Appendix*. Screeding would be the loudest in-water noise created, estimated at 164 to 179 dB root mean square (rms) at 3.28 feet from the source (Blackwell and Greene 2003). These sound pressure levels would be within the range that could cause behavioral avoidance in fish but would fall below levels that would injure or kill fish (Buehler, Oestman et al. 2015). Other in-water work (contouring of the fill and pile removal) would be even quieter than screeding. It is anticipated that piles and sheet piles would be installed during winter, when sea ice was bottom-fast, and thus there would be no effects to fish from pile installation.

Increased marine vessel traffic could disturb and locally displace nearshore marine fish due to noise. Disturbance or displacement from vessels would occur during vessel activity (limited to the open-water seasons during construction) and be limited to the nearshore barge route. Individual fish may be affected, but populations would not.

Placement of gravel fill in marine waters could bury fish and other bottom-dwelling organisms in the fill footprint. Effects would be limited to the fill footprint and would occur one time during gravel placement. Thus, mortality would not impact any fish at the population level.

Screeding could also injure or cause mortality to bottom-dwelling fish within the screeding footprint. Screeding would occur 2 times and would not affect fish at the population level.

3.10.2.6.1 Option 2: Point Lonely Module Transfer Island

All the effects to fish and fish habitat described for Option 1 would apply to Option 2, as shown in Table 3.10.1. Nearshore marine fish species at Point Lonely are similar to Atigaru Point, with the addition of Bering cisco (*Coregonus laurettae*) (Schmidt, McMillan et al. 1983). The soft-bottom benthic assemblage offshore of Pitt Point (Carey, Ruff et al. 1981) also appears similar to Atigaru Point benthos. Option 2 would have the same design, size, and water depth as Option 1.

The main difference between the two options is that Option 2 would require double the freshwater withdrawal for about twice the length of ice roads (Table 3.10.1), which might cause more habitat alteration if lakes do not recover to pre-withdrawal levels. Additionally, Option 2 would have markedly more miles of support vessel traffic to and from Oliktok Point, which would cause more local disturbance and displacement of fish in the vessel route.

3.10.2.7 Oil Spills and Other Accidental Releases

The EIS evaluates the potential impact of accidental spills. Chapter 4.0 (*Spill Risk Assessment*) describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste and hazardous materials (such as diesel, gasoline, and other chemicals) during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to negatively affect fish or aquatic habitats.

Spills from oil infrastructure could occur during drilling and operations from leaking wellheads, facility piping, process piping, or aboveground storage tanks but would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. In the unlikely event that a pipeline spill occurs at a river crossing during high water flow, the extent of the accidental release could be larger and affect fish habitat and EFH. A spill from a pipeline crossing of streams in the Willow area may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. As described in CPAI (2018a), the relatively low flow and highly sinuous nature of streams in the Fish (Uvlutuuq or Iqalliqpik) Creek and Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay.

If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels; however, a reservoir blowout is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

Seawater spills on nonfrozen waterbodies could have effects that would last for several years depending on the size of the spill and the size of the waterbody. Seawater spills would affect salt-tolerant fish species (like ninespine stickleback) less than more sensitive species, such as Arctic grayling.

3.10.2.8 Effects to EFH

All the types of effects to habitat described above would apply to EFH. Because not all stream crossings would be in EFH, Alternative B would fill 440.3 square feet of freshwater EFH due to piles and VSMs below OHW. Alternative C would fill 474.5 square feet, and Alternative D would fill 440.3 square feet (Table E.10.2 in Appendix E.10). All alternatives would fill less than 0.01 acres of freshwater EFH. All the effects to marine habitat described for the MTIs would be in EFH. The Draft EFH document for the Project will be included in the Final EIS.

3.10.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. Additional suggested mitigation measures to reduce impacts to fish could include:

1. As agencies determine is appropriate, the mine site could be reclaimed to create overwintering habitat that is connected to anadromous streams. The site is approximately 266 feet from Bills Creek and 310 feet from the Ublutuoch (Tiŋmiaqsiġvik) River. Overwintering habitat is limited in the analysis area and could benefit multiple fish species and aquatic organisms.

The Project could adopt the following BMPs suggested by NMFS for EFH for invasive species (Limpinsel, Eagleton et al. 2017).

1. Uphold fish and game regulations of the Alaska Board of Fisheries (AS 16.05.251) and Board of Game (AS 16.05.255), which prohibit and regulate the live capture, possession, transport, or release of native or exotic fish or their eggs.
2. Adhere to regulations and use BMPs outlined in the State of Alaska Aquatic Nuisance Species Management Plan (ADF&G 2002).
3. Encourage vessels to exchange ballast water in marine waters (in accordance with the U.S. Coast Guard's voluntary regulations) to minimize the possibility of introducing invasive estuarine species into similar habitats. Ballast water taken on in the open ocean would contain fewer organisms, and these would be less likely to become invasive in estuarine conditions.
4. Discourage vessels that have not exchanged ballast water from discharging their ballast water into estuarine receiving waters.
5. Require vessels brought from other areas over land via trailer to clean any surfaces (e.g., propellers, hulls, anchors, fenders) that may harbor non-native plant or animal species. Bilges should be emptied and cleaned thoroughly by using hot water or a mild bleach solution. These activities should be performed in an upland area to prevent the introduction of non-native species during the cleaning process.
6. Prior to the start of construction, undertake a thorough scientific review and risk assessment regarding impacts associated with the introduction of non-native species.

3.10.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Some unavoidable and irretrievable loss of fish habitat would occur throughout the life of the Project; impacts would not be irreversible and would not affect the long-term sustainability of fish resources. However, irreversible direct mortality to fish and benthic organisms would occur as a result of screeding and gravel fill required for the MTI. These irreversible impacts would be relatively small and would not impact population viability of impacted species. The alteration of nearshore habitat would also be irreversible because even if the MTI is abandoned and reshaped, it would still exist.

3.11 Birds

The analysis area for birds, which encompasses the area of direct and indirect effects to birds, is the area within a 3.7-mile (6-km) radius of gravel and ice infrastructure, mine sites, module delivery sites, and Project actions (Figure 3.11.1). The 3.7-mile (6-km) radius is based on decreased nest survival of some species within 3.1 miles (5 km) of oilfield facilities (Liebezeit, Kendall et al. 2009). Movements of more than 3.7 miles are possible for foraging gulls, ravens, and raptors, which may be attracted to artificial food, nest sites, or perch sites (Engle and Young 1992; Weiser and Gilchrist 2012; White, Clum et al. 2002).

The temporal scale for analysis of impacts to birds is the life of the Project and reclamation. Reclamation of onshore areas is expected to take at least 20 to 30 years (Section 3.9, *Wetlands and Vegetation*). If reclamation did not occur, effects would be permanent. The temporal scale for construction impacts related to human presence and noise would last only through construction.

3.11.1 Affected Environment

3.11.1.1 Bird Species

Between 80 and 90 bird species may occur in the analysis area and nearshore waters of the Beaufort Sea (BLM 2004a, 2012b); approximately 50 species regularly occur or are common (Appendix E.11, *Birds Technical Appendix*). Ground-nesting shorebirds are the most abundant breeding birds (in terms of number of species and number of breeding individuals) followed by passerines, waterfowl, loons, seabirds, ptarmigan, and raptors. Nearly all species are seasonal migrants using the ACP during the breeding season. The exceptions are rock and willow ptarmigan, gyrfalcon, snowy owl, and common raven, which can be year-round residents (Johnson and Herter 1989).

3.11.1.1.1 Special Status Species

Two species possibly occurring in the analysis area, spectacled and Steller's eider, are listed as threatened under the ESA. Small numbers of spectacled eiders occur in the analysis area annually during **pre-breeding** and **post-breeding** (Johnson, Parrett et al. 2019; Sexson, Pearce et al. 2014), but nesting has not been confirmed. Steller's eiders are rare, and primarily breed in the area near Utqiaġvik (Barrow) (Johnson, Shook et al. 2018; Quakenbush, Day et al. 2002). The most recent sightings of Steller's eider in the analysis area were during pre-breeding in 2013 (1 pair) near Point Lonely, 2006 (1 male) near Atigaru Point (USFWS 2016, unpubl. data), and 2001 (1 male flying) near GMT-2 (Johnson, Shook et al. 2018).

Nine species of birds in the analysis area are listed as sensitive animals by the BLM (2019), and nine species are listed as Birds of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS 2008a) (two of which are not on the BLM list). All special status species are described in more detail in Appendix E.11.

This EIS focuses on two special status species: yellow-billed loon (a common breeder in the analysis area) and spectacled eider (a possible breeder in the analysis area), see Table E.11.1 in Appendix E.11. Best management practices for both species are prescribed in the NPR-A IAP/EIS ROD (BLM 2013a). Densities of these species in the analysis area are depicted in Figures 3.11.2 through 3.11.4.

3.11.1.2 Bird Habitats

Birds typically use the ACP (including the analysis area) during several important life history stages: pre-breeding, nesting, **brood-rearing**, **molting**, and **fall-staging**. Few species winter on the ACP. Generally, higher densities of nesting birds are found in coastal rather than interior ACP areas (Andres, Johnson et al. 2012; Johnson, Burgess et al. 2004). Shorebirds, waterfowl, loons, gulls, and terns favor areas with deep and shallow lakes with low relief shorelines; marshes, patterned wet and moist meadows, and drained lake basins (Cotter and Andres 2000; Johnson, Burgess et al. 2003). Nesting songbirds tend to use moist meadows and shrub areas. Available data on habitat use by 71 species that may occur in the analysis area are summarized in Table E.11.1 of Appendix E.11. The habitats were ranked by the number of species using them to portray areas with the highest potential for avian occurrence (Figure 3.11.5 and Table E.11.2 in Appendix E.11). The most common habitats in the analysis area are Moist Tussock Tundra and Patterned Wet Meadow (Table E.11.2 in Appendix E.11). Moist Tussock Tundra tends to support lower densities of breeding birds than Patterned Wet Meadow and other aquatic and wet habitat types. The highest number of bird species use Patterned Wet Meadow (44 species) and Nonpatterned Wet Meadow (39 species).

3.11.1.2.1 Special Status Species Habitats

Habitat use by special status species is summarized in Table E.11.1 and by spectacled eiders in Table E.11.3 of Appendix E.11. Spectacled eiders have been documented in the analysis area during the pre-breeding (Johnson, Parrett et al. 2019) and nearshore during post-breeding periods (Fischer and Larned 2004), but nesting has not been confirmed because nest searches have not been conducted in the analysis area.

3.11.2 Environmental Consequences

3.11.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.11.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate impacts to bird from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to bird habitat, subsistence hunting and fishing areas, and the environment, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.11.1 Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Birds

LS or BMP	Description or Objective	Requirement
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from the ordinary high-water mark of fish-bearing waterways.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-9	Avoidance of human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.

LS or BMP	Description or Objective	Requirement
BMP E-11	Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.	Before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction. Roads and facilities shall be sited to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Power and communication lines shall either be buried in access roads or suspended on vertical support members except in rare cases. Communication towers should be located on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers and other similar facilities, should be avoided. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low flying birds. Maintain a 1-mile buffer around all recorded Yellow-billed Loon nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.
BMP E-18	Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests.	Activity within 200 meters of occupied nest will be restricted to existing pads and roads from June 1 to August 15; construction is prohibited within 200 meters of occupied nests. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller's and/or spectacled eider nests will be prohibited.
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and an altitude of at least 1,500 feet above ground level when within ½ mile of known gyrfalcon nest sites from March 15 to August 15. Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area should be minimized from May 20 through August 20.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
LS/BMP K-1	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or over-wintering fish habitat; minimize the loss of raptor habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).

LS or BMP	Description or Objective	Requirement
BMP K-4a	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins. Within the Goose Molting Area, aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20. Other restrictions are specified.
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; protect summer and winter shoreline habitat; and prevent loss or disturbance of shoreline marshes.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect birds would include those to LS E-2 and BMPs E-11, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMPs K-1 and K-2) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2 in Section 3.10, *Fish*). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also cross the standard disturbance setback of 1 mile around recorded yellow-billed loon nest sites and 500-meters (1,625-feet) around the shoreline of nest lakes (Figure 3.11.4).

3.11.2.2 Alternative A: No Action

Under Alternative A, seasonal ice roads and pads (and associated water withdrawals), seismic surveys, and exploratory drilling could continue to occur in the analysis area to support oil and gas exploration. Effects from the existing infrastructure and activities in the Alpine and GMT oilfields would continue.

3.11.2.3 Alternative B: Proponent's Project

3.11.2.3.1 Habitat Loss or Alteration

Project activities with the potential to cause habitat loss or alteration include the following:

- Fill for new gravel roads and pads
- Gravel spray and dust deposition from roads and pads
- Altered drainage patterns adjacent to gravel and ice infrastructure
- Delayed melt of snow in drifts, compressed snow, and ice from ice infrastructure
- Water withdrawal from lakes
- Gravel mining and mine rehabilitation

Alternative B would permanently remove 672.2 acres of bird habitat due to gravel fill. Tables E.11.4 and E.11.5 in Appendix E.11 detail loss and alteration by habitat type and alternative. High-value habitats (used by 20 or more species) comprise 39% (264.8 acres) of the area lost to gravel fill. Total habitat loss would be a small fraction of the total area of bird habitat within the analysis area (893,977.5 acres). Habitat loss should affect small numbers of nesting birds due to the small area lost; most displaced birds could relocate to similar habitats available in the analysis area.

Gravel spray and dust deposition from the use of new gravel roads would alter bird habitats within 328 feet (100 m) of gravel infrastructure (described in Section 3.4, *Soils, Permafrost, and Gravel Resources*). Gravel and dust could displace small numbers of birds to other habitats or reduce the quality of forage or nesting cover in the affected areas throughout the life of the Project. Effects would be both ephemeral (early thaw) and permanent (changes in vegetation composition and structure). Alternative B would alter 3,466.8 acres of bird habitats due to dust deposition, or less than 1% of the analysis area. Although most effects are negative, early snow and ice melt caused by the dust shadow is attractive to some early spring migrants who would gain access to thawed areas.

Gravel and ice infrastructure could create impoundments and cause changes in drainage patterns that would alter habitats immediately adjacent to infrastructure. If the impoundments caused thermokarsting, the effects would likely be permanent. Effects could decrease habitat quality and available forage or nesting habitat. Impoundments could also create new foraging, nesting, and brood-rearing habitat that would be beneficial for some bird species such as Pacific loons (Kertell 1996), although the proximity to roads also may increase the potential for collisions with vehicles.

Snowdrifts from snow cleared off gravel infrastructure and compressed snow and ice from ice infrastructure might delay snowmelt until after birds have initiated nesting, causing annual temporary loss of nesting habitat for small numbers of birds in these areas. Effects would likely occur in years of late snow and ice thaw. Ice infrastructure could compress vegetation, especially standing dead vegetation used for concealment by some nesting birds and alter habitats. The severity of impacts from compressed snow and ice are described in Section 3.9, *Wetlands and Vegetation*. Overall, 2,872.3 acres covered by ice infrastructure would be temporarily altered. Birds should be able to use similar habitats in the analysis area.

Water withdrawal from lakes could lower water levels if lakes do not fully recharge in spring (Section 3.8, *Water Resources*). Decreased water levels would alter lake and shoreline habitats for small numbers of nesting waterbirds and shorebirds and could reduce suitability for nesting or expose nests to predation, particularly at small islands and low-lying shoreline areas. Lowered lake levels might also impact bird forage species (invertebrates and fish). The State regulates water withdrawal with restrictions on volumes of water removed (Section 3.10), which should minimize some or all negative effects. Potable water would be withdrawn year-round from Lakes M0015 and R0064 (Figure 3.11.4, for permitted lakes, and Table E.11.7, in Appendix E.11, for withdrawal volumes) for the life of the Project. These two lakes are not known to support yellow-billed loon nests or broods. Winter water withdrawals for ice infrastructure could occur from any permitted lake in the Willow area during construction. Because yellow-billed loons have high nest lake fidelity (Johnson, Wildman et al. 2019; Schmutz, Wright et al. 2014), they likely would not move to other lakes and could be impacted by withdrawals that occur at nesting lakes. Impacts to these and other special status species are detailed in Section 3.11.2.3.5, *Special Status Species*.

Excavation of the mine site would result in permanent alteration of approximately 229.6 acres of bird habitat, mostly Moist Tussock Tundra and Moist Sedge-Shrub Meadow. Regardless of specific details for reclamation (e.g., if the pits would be connected to streams), the pits would fill with water (from ground or surface water, or from permafrost melt) and thus would become water habitat and result in a loss of habitat for tundra-nesting birds and a gain in habitat for waterbirds. The mine could displace less than 80 nests, primarily of ground-nesting shorebirds and passerines, based on average densities from breeding bird plots (Johnson, Burgess et al. 2005). A mine site reclamation plan would be coordinated with agencies prior to the start of mining.

3.11.2.3.2 Disturbance or Displacement

Project activities that could potentially disturb or displace birds include the following:

- Increased human activity
- Increased noise and visual disturbance from machinery as well as ground, air, and marine traffic
- Increased noise and visual disturbance from flaring and drill rigs or other infrastructure

Disturbance can increase concealment behaviors, decrease nest attendance, or interfere with resting, feeding, and brood-rearing activities. It can also increase energetic costs or lead to displacement of breeding birds, which may increase nest and brood predation, thereby reducing reproductive success. The area of disturbance (from all summer terrestrial activities listed above) would be 9,442.3 acres, during all Project phases, based on a 656-foot (200-m) disturbance zone around gravel infrastructure and pipelines (5,071.7 acres or 54% would be in habitats used by 20 species or more; Table E.11.6 in Appendix E.11). Bird responses to disturbances vary by disturbance source and bird species, with some raptors reacting at the farthest distances (Livezey, Fernandez et al. 2016). The USFWS established a 656-foot (200-m) zone around nesting spectacled eiders (during June 1 to 31 July) where human activities off gravel pads and roads are prohibited (USFWS 2015a, 2018). This zone encompasses all effective disturbance distances summarized for related species and families of birds nesting in the analysis area (Livezey, Fernandez et al. 2016) and is used here to estimate the area affected by human activity, noise, traffic, and machinery. The one exception to this disturbance zone is tundra swans, which react at 1,640 to 6,562 feet (500 to 2,000 m) (Monda, Rattie et al. 1994).

Human activity would be greatest during construction. Effects to birds during construction would be minimized by scheduling heaviest construction activities during winter, when few birds are present.

Noise and visual stimuli from ground and air traffic would disturb or displace birds throughout the life of the Project. Routine aircraft flights could result in bird avoidance of certain areas, abandonment of nesting attempts, or reduced survival of eggs and young. Ground and air traffic would be highest during winter construction (December to April), when few birds use the analysis area. During this time, there would be 9.3 fixed-wing plane landings per day at Willow from 2022 through 2027, and 1.2 plane landings per day at Alpine. There would also be 0.5 helicopter trips per day at Willow, and 0.4 helicopter trips per day at Alpine. There would be 68 ground traffic trips per hour to Willow. Table E.11.8 in Appendix E.11 provides details on traffic. Hazing birds at or near airstrips would temporarily disturb or displace additional individual birds.

Disturbance and displacement would be lower in intensity during operations than during construction and drilling because ground traffic would decrease by approximately 89% and air traffic would decrease by approximately 65% with a proportional decrease in associated noise (Table E.11.8 in Appendix E.11). Traffic disturbance to most species of birds would occur within 200 m of gravel infrastructure; impacts would be greatest during summer because more birds are present.

Increased subsistence access via gravel roads could also displace or disturb birds and change their distribution or local abundance. Section 3.16 (*Subsistence and Sociocultural Systems*) describes estimated changes in subsistence access and potential harvest due to project infrastructure.

3.11.2.3.3 Injury or Mortality

Birds within the analysis area could be injured or killed due to collisions with vehicles, aircraft, or Project infrastructure and from increased subsistence harvest.

The addition of new roads and airstrips and increased use of vehicles and aircraft during construction and operation would increase the potential for bird collisions. Dust along roads could cause early snowmelt and early green-up adjacent to gravel infrastructure, which could attract birds, increasing the potential for individual bird strikes from vehicles. Collision rates for birds in the Alpine and GMT developments from 2015 to June 2019 ranged from 0 to 2 collisions per year, as reported by CPAI. One of the 4 total collisions reported was from an aircraft.

Structures such as communication towers, flare towers, buildings, elevated pipelines, and drill rigs would pose collision hazards during periods of poor visibility (MacKinnon and Kennedy 2011). The tallest structures would be communications towers (up to 200 feet tall) and drill rigs (up to about 230 feet tall). There would be one communication tower at the WOC and one at each drill site for a total of six, as well as one to two drill rigs operating at any given time during the drilling phase (one drill rig per drill site pad). In addition, facility and tower lighting, as well as flaring at the CPF, under low-light conditions, could disorient birds and lead to collisions or exhaustion (Day, Rose et al. 2001; Day, Rose et al. 2015; Ronconi, Allard et al. 2015). Weather conditions such as fog, rain, and low light increase collision mortality of common eiders at towers and transmission lines (MacKinnon and Kennedy 2011). On the North Slope, birds often migrate at low altitudes and in foggy conditions; eiders migrate an average of 40 feet (12 m) above ground level at Point Barrow (Day, Stenhouse et al. 2001) and 30 feet (9 m) above ground level at Northstar Island (Day, Prichard et al. 2005). Collision risk would be lower inland, where the towers would be located, because fewer species migrate in that area and visibility is better. Inland communication towers would be up to 200 feet tall. Permanent towers would be triangular, self-supporting lattice towers and would not use guy wires. Temporary towers would be pile supported and may require guy-wires, which would increase collision risk; guy wires would include devices to mitigate bird strikes. Collision risk would be further minimized by shielding lights downward on towers and buildings. Effects could occur to individual or flocks of birds around tall structures throughout the life of the Project. Of the 21 bird mortalities reported at BP facilities on the North Slope in 2013, 3 were known vehicle collisions and 3 were known building collisions (Streever and Bishop 2014). BP facilities are in an area of the North Slope with more structures, more roads, faster vehicle speeds, and more air traffic than the Willow Project would have. Collisions from the Project are expected to be less than those at the BP facilities.

Increased subsistence use due to new gravel roads could reduce nest success and adult survival of waterfowl due to hunting and egg gathering. Egg gathering now occurs near Alpine CD5 and the GMT-1 road, in part due to increased access. Section 3.16, *Subsistence and Sociocultural Systems,* describes changes in subsistence access.

3.11.2.3.4 Attraction to Human Activity and Facilities

Some scavenging or predatory bird species, such as glaucous gulls and common ravens, would be attracted to tall structures and facilities (such as buildings, elevated pipelines, bridges, towers, drill rigs, and wellheads) that provide perching or nesting habitat. This could lead to increased predation of other birds or bird nests in these areas. Some species of songbirds (snow buntings and redpolls) are also attracted to human structures for nest sites. The impact of increased nest predation would vary depending on the species attracted and the vulnerability of the nesting species. The effect would extend throughout the analysis area.

Two avian predators, glaucous gulls and common ravens, are attracted to human food (Day 1998; NRC 2003). The populations of these two species have increased on the ACP over the last 10 years (Stehn, Larned et al. 2013), which may be a result of increased availability of human foods and, for ravens, nesting sites on human-made structures. Some mammalian predators of birds, such as foxes and bears, are also attracted to human food (Section 3.12, *Terrestrial Mammals*). Effective food and garbage control (described in the Project Waste Management Plan) should minimize the attraction of predators to Project facilities.

3.11.2.3.5 Special Status Species

Steller's eiders, whimbrels, buff-breasted sandpipers, and red knots are unlikely to be affected by habitat loss, or disturbance or displacement, because they are rare in the vicinity of the Project. Peregrine falcons are rare breeders in the analysis area and use steep bluffs and human structures as nesting sites. Spectacled eiders, yellow-billed and red-throated loons, bar-tailed godwits, dunlin, and arctic terns, depending on their local occurrence, could be subject to all of the effects described above.

Because yellow-billed loons have high nest lake fidelity (Johnson, Wildman et al. 2019; Schmutz, Wright et al. 2014), they could be impacted by water withdrawals or human disturbance that occurs at nesting lakes. Impacts would likely occur at the individual level. Neither of the potable water source lakes (Lakes M0015 and R0064) support yellow-billed loon nests or broods (Figure 3.11.4). Winter water withdrawals for ice infrastructure could occur from any permitted lake in the Willow area during construction. BMP E-11 stipulates no development within 1 mile from a yellow-billed loons' nest and 1,640 feet from a breeding lake. Eight unique nest sites (some occupied for at least 1 year) are known to occur within 1 mile of the proposed gravel infrastructure for Alternative B; 4 breeding lakes are known within 1,640 feet. A deviation to BMP E-11 would be needed for these sites.

Impacts of water withdrawal on nesting spectacled eiders are possible, but their density near permanent Project facilities is low (Figure 3.11.2). Effects would be restricted to permitted waterbodies, and unlikely affect more than a few individual shoreline and island nesting eiders. Approximately 32.8 acres of spectacled eider preferred habitat would be permanently lost to gravel fill under Alternative B. Based on estimated density from aerial pre-breeding surveys, 0.002 nests could occur annually in the area that would be filled (Figure 3.11.2). Appendix E.11 provides more details on effects to special status species.

3.11.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences. Under Alternative C, 44.9 more acres of habitat would be lost due to gravel fill; 48.1 more acres of habitat would be indirectly impacted by dust and gravel spray; and 438.9 more acres of habitat would be impacted by disturbance associated with noise and visual stimuli from people, vehicles, machinery, and additional aircraft activity. Appendix E.11 provides more details and impact comparison tables for action alternatives. Approximately 27 more acres of high-use habitats would be lost to gravel fill due to a larger gravel footprint. There would be two additional seasons of ice roads and water withdrawal during construction, as well as an annual ice road required for the life of the Project, which could have longer lasting effects on water levels if lakes used by nesting waterbirds are used for water withdrawal. Approximately 528.0 more acres would be covered by ice infrastructure and could be altered by vegetation damage and compacted soil. Alternative C would have 7 known unique nest sites of yellow-billed loons within 1 mile of gravel fill and 4 breeding lakes within 1,640 feet. A deviation to BMP E-11 would be needed for these sites.

Alternative C would have 22% less ground traffic than Alternative B, but 1.3% more air traffic (Table E.11.8 in Appendix E.11). During winter construction, there would be 0.4 more fixed-wing plane landings per day at Willow from 2022 through 2027 (air traffic at Alpine would be the same as Alternative B). There would also be 0.6 more helicopter trips per day, and 5.1 fewer ground traffic trips per hour. Air traffic would decrease by 65% during operations (2036–2050), and ground traffic would decrease by 93%, with a proportional decrease in associated noise disturbance and displacement.

3.11.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those as described under Alternative B, with the following differences. Under Alternative D, 32.1 fewer acres of habitat would be lost due to gravel fill; 766.4 fewer acres of habitat would be indirectly impacted by dust and gravel spray; and 722.9 fewer acres of habitat would be impacted by disturbance associated with noise and visual stimuli from people, vehicles, machinery, and additional aircraft activity. Appendix E.11 provides more details and impact comparison tables for action alternatives. Approximately 24 fewer acres of high-use habitats would be lost to gravel fill due to a reduced gravel footprint. There would be two additional seasons of ice roads and water withdrawal during construction, as well as an annual ice road required for the life of the project, which could have longer lasting effects on water quantity in water source lakes used by nesting waterbirds. Approximately 1,578.9 more acres would be covered by ice infrastructure and could be altered by vegetation damage and soil compaction. Alternative D would have 8 yellow-billed loon nests (unique nest sites) within 1 mile of gravel fill and would have 3 breeding lakes within 1,640 feet. A deviation to BMP E-11 would be needed for these sites.

Alternative D would have 6% more ground traffic and 27% more air traffic than Alternative B (Table E.11.8 in Appendix E.11). Though there would be a slight increase in air traffic during winter construction, there would be markedly more air and ground traffic during both summer and winter 2028 through 2032. During winter construction, there would be 0.7 more fixed-wing plane landings per day at Willow than Alternative B (2022 through 2027), and 0.5 more fixed-wing plane landings per day at Alpine. There would also be 0.1 more helicopter trips per day. There would be 7.5 fewer ground traffic trips per hour during onstruction, but 10.3 more trips per hour from 2028 to 2032. Fixed-wing plane traffic would decrease by at least 64% during operations (2036–2050) with a proportional decrease in associated noise disturbance and displacement; ground traffic would decrease by 89% during operations.

3.11.2.6 Module Delivery Options

Many of the effects described for Alternative B would also apply to the module delivery options, such as habitat alteration from gravel mining, ground and air traffic, attraction to human facilities, and collision with structures. Effects to birds unique to the module delivery options are summarized in Table 3.11.2.

3.11.2.6.1 Option 1: Proponent's Module Transfer Island

Screeding at the MTI would temporarily alter habitats by increasing turbidity in the area immediately surrounding the screeding footprint. Birds such as long-tailed ducks, eiders, scoters, and red-throated loons that depend seasonally on this habitat for foraging could experience decreased foraging success due to turbidity. Additionally, screeding would temporarily decrease availability of benthic foods in the screeding footprint, which could be used by seaducks. Because the screeding footprint is 4.9 acres and the action would only occur in two separate summer seasons, the effects would be temporary, localized, and affect small numbers of birds in an area where a large amount of alternative foraging habitat is available.

Birds in the nearshore marine area around the MTI would also be disturbed or displaced due to in-water work (screeding, recontouring of the MTI slopes, and pile removal), noise (both airborne and underwater), and human activity. In-water work and underwater noise would occur over two summer seasons. Airborne noise would occur during one winter construction season around the MTI site. Human activity would occur over several winter and summer seasons through construction and decommissioning.

Birds along the nearshore barge and support vessel route (foraging long-tailed ducks, scoters, eiders, loons, and geese) could be temporarily disturbed or displaced due to slow-moving vessels. Effects would occur during three open-water seasons (July 7 through September 30), be localized, and although it could affect multiple species, alternative marine habitats are abundant in the area. Six barge trips and 224 support vessel trips would be needed (Table E.11.10 in Appendix E.11).

Two temporary communication towers (one on the MTI and one on an onshore multi-season ice pad) up to 120 feet tall would be erected at the start of MTI construction (2021) and held in place via guy-wires. Risk of collision with towers would be greatest along the coast, because spectacled eiders (Sexson, Pearce et al. 2014) and other sensitive species follow the arctic coastline during migration (Day, Prichard et al. 2005; Day, Rose et al. 2001) and because fog and poor visibility are common in that area. Guy-wires significantly increase collision mortality for birds (Gehring, Kerlinger et al. 2011), therefore guy-wires would be fitted with bird divertors to mitigate potential bird collisions. The temporary tower would remain in place until the first season of module delivery is complete (2023), at which time it would be demobilized until the second season of module delivery (2025). It would then be reinstated until MTI decommissioning. As described in Section 3.11.2.3.3, *Injury or Mortality*, birds could collide with the communications tower and be injured or die.

Table 3.11.2. Effects to Birds and Bird Habitat from Module Delivery Options

Project Component	Effect to Bird or Bird Habitat	Option 1: Proponent's MTI	Option 2: Point Lonely MTI
Gravel fill in marine area	Open nearshore water and benthic habitat loss Temporary habitat alteration from sedimentation or turbidity Disturbance or displacement from noise	12.8 acres lost 11 to 15 acres altered 72.5 acres of disturbance	13.0 acres lost 11 to 15 acres altered 72.7 acres of disturbance
Pile and sheet pile removal[a]	Disturbance or displacement from airborne and underwater noise	129 dB at 328 feet from the source[b] 36 days of activity; 9 pipe piles; 685 (30 to 40 foot) sheet piles	Same as Option 1
Screeding	Temporary habitat alteration (increased turbidity, and decreased benthic forage) Disturbance or displacement from noise or human activity	4.9 acres altered, 2 occurrences 72.5 acres of disturbance	Same as Option 1 72.7 acres of disturbance
Barging of materials, support vessels	Temporary disturbance or displacement from noise or human activity	Temporary disturbance along nearshore barge and support vessel routes ~600 more miles of sealift barge traffic[c]	Temporary disturbance along nearshore barge and support vessel routes ~22,400 more miles of support vessel traffic[c]
Freshwater ice roads	Habitat alteration from water withdrawal (water quality or quantity changes) Habitat alteration from vegetation disturbance	521.2 million gallons of water 109.9 miles of onshore ice road 1,355.3 acres of onshore ice roads and ice pads	1,004.9 million gallons of water 227.9 miles of onshore ice road 2,753.2 acres of onshore ice roads and ice pads
120-foot-tall communication tower	Injury or mortality from collision with tower or guy-wires	2 towers: 1 on the MTI and 1 on an onshore multi-season ice pad. Towers erected from 2021 through summer 2023, and from summer 2025 to MTI decommissioning.	3 towers: 1 on the MTI and 2 on an onshore multi-season ice pad. Towers erected from 2021 through summer 2023, and from summer 2025 to MTI decommissioning.

Note: dB (decibels); MTI (module transfer island). All sound levels are detailed in Appendix E.13, *Marine Mammals Technical Appendix*.
[a] No underwater noise anticipated from pile and sheet-pile installation since gravel would be placed and piles would be driven through grounded ice. Airborne noise from pile installation is not expected to affect birds because most birds do not use sea ice habitats in winter, although common ravens could be attracted to human activity near shore.
[b] Pangerc et al. 2017
[c] Both options would have the same number of trips, but distance traveled would vary by option. Atigaru Point is approximately 50 miles from Point Lonely. Six round-trip barge trips over that distance is 600 miles. Barges would travel from southern Alaska. Support vessels would originate at Oliktok Point; 224 round-trip support vessel trips over 50 miles is 22,400 miles.

3.11.2.6.2 Option 2: Point Lonely Module Transfer Island

All of the effects to birds described for Option 1 would apply to Option 2. The main difference is Option 2 would require double the water withdrawal for about twice the length of ice roads (Table 3.11.11), which would cause more habitat alteration from vegetation compression and lower lake levels if lakes do not recover to pre-withdrawal levels. Option 2 would also have markedly more miles of support vessel traffic. Though the number of trips and seasons of use are the same as Option 1, the support vessels would originate from Oliktok Point and thus would have a longer route to Point Lonely than Atigaru Point. This would increase disturbance and displacement to birds using nearshore waters. Both locations have large numbers of sea ducks, loons, and molting and brood-rearing brant and other geese, which could be disturbed or displaced by human activity and loss of benthic forage during summer. Option 2 would also require substantially more air traffic (to Willow, Alpine, and Point Lonely) than Option 1 (Tables E.11.9 through E.11.11 in Appendix E.11), thus would have more disturbance and displacement as well as injury or mortality from collisions.

The temporary communication tower for Option 2 would be the same as for Option 1 except that an additional repeater tower would be required (on an onshore multi-season ice pad) due to the distance from Point Lonely to the GMT-2 tower. Thus, risk of mortality or injury would be higher in Option 2 with three towers than from the two towers in Option 1.

3.11.2.7 Oil Spills or Other Accidental Releases

The EIS describes effects of accidental spills. As described in Chapter 4.0, *Spill Risk Assessment*, the risk of a large spill during any phase of the Project would be very low. The risk of a very small to small spill or leak is probable over the life of the Project, and most likely to occur over gravel infrastructure, which would be easier to contain and remediate. Effects from oil spills and accidental releases on birds and their habitat would depend on the location and season of the spill. Numerous safeguards are required and would be specified in CPAI's ODPCP. The relatively small amounts of material that could be released under most scenarios, and the ability to detect and respond to spills quickly, would minimize potential effects.

Light to moderate oiling of birds can reduce reproduction (through pathological effects on breeding birds or transfer of oil to eggs) or survival (Albers 1980; Anderson, Newman et al. 2000; Lewis and Malecki 1984). Heavy oiling of birds would be lethal and cause hypothermia or mortality through ingestion and inhalation (Clark 1968; Hartung 1967; Holmes, Cronshaw et al. 1978). The effects of other toxic material spills could be similar or more severe, depending on the material. Oil spills on tundra or in water are extremely rare, as are large spills (greater than 10,000 gallons). Releases to tundra could threaten breeding and non-breeding birds, but such releases would be rare and would not spread widely unless undetected. Spills to waterways (if not frozen) would likely spread farther and faster.

In the very unlikely event of a spill at a pipeline crossing of streams in the Willow area, oil may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the Fish (Iqalliqpik) Creek and Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay. If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels. However, a reservoir blowout is unlikely to reach Harrison Bay, due to the distance to the drill sites and the sinuous nature of the streams in the area.

Because many birds use the river channels, marshes, and lakes around river channels, contamination of these areas during spring breakup to fall could affect large numbers of birds. Although effects of such spills could be severe, the probability of such spills occurring would be unlikely. Their duration would be a few days to weeks, although cleanup could prolong the duration of impacts. Effects from very small to small spills would be probable during the life of the Project but would be minor because they would be restricted to pads and roads or not spread more than 1 or 2 acres on tundra. Effects would be infrequent and last hours to a few days.

Most spills to the marine environment would have a low to very low likelihood and occur during construction of the MTI or originate from small support vessels. These very small to small spills would be localized to the immediate area of the MTI. A larger spill from a barge would have a very low likelihood, and would only occur if a tug or barge transporting modules were to run aground, sink, or if its containment compartment(s) were breached and the contents released (USACE 2012). The geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Seabirds and potentially shorebirds could be affected.

Seawater spills on nonfrozen tundra would have effects on plants used by birds forage or cover that could potentially last many years. Saltwater spills can be toxic to many plant species, long lasting, and can cause leaf deterioration and deleafing (Simmons 1983). Wetter sites recover more rapidly. Willow species (*Salix* spp.) and mountain avens (*Geum* spp.) have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.11.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. In addition, the following mitigation could reduce impacts to birds:

1. Locate mast poles away from the pad edge
2. Use lighting fixtures with lamps contained within the reflector
3. Shade externally facing windows on buildings to minimize impacts on visual aesthetics and the potential for bird strikes
4. Shield lighting downward to reduce attraction and disorientation of birds in poor visibility conditions
5. Minimize the number of tall towers
6. Limit water withdrawal to lakes without sensitive fish or breeding yellow-billed loons
7. Restrict speed limits to minimize collision hazard and dust production (35 miles per hour except in areas of congestion, on bridges, and on pads, which should be slower)
8. Haze birds out of blast area before blasting
9. Monitor lake levels to ensure sufficient recharge is occurring and adjust future withdrawals accordingly to allow for sufficient recharge

10. Minimize noise impacts between June 1 and July 15 when birds on nests would be unable to move away from the disturbance
11. Minimize air traffic during the nesting period when the movements of incubating birds are restricted, and the molting period when birds may be energetically stressed and sensitive to disturbance
12. Require aircraft fly at altitudes higher than 1,500 feet to minimize effects to birds; consult with BLM to determine altitude
13. Avoid routine use of helicopters during drilling and operations activities to minimize noise and impacts related to birds
14. Consider revising traffic pattern altitude and location to minimize conflicts with nesting and foraging birds
15. Avoid preferred habitats, where possible
16. Minimize barge and support vessel speed to reduce potential for bird strikes

3.11.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with BMPs in place, some unavoidable impacts to birds would occur, including direct loss of habitat and disturbance and displacement due to noise, human activity, and visual disturbance. These impacts would be irretrievable throughout the life of the Project but would not be irreversible or affect the long-term sustainability of wildlife in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.12 Terrestrial Mammals

The analysis area for terrestrial mammals is the area within 3.7 miles of construction or operation activities and structures (Figure 3.12.1), based on research that documented decreased density of maternal caribou within 0.6 to 3.7 miles (1 to 6 km) of active roads and pads during a 2- to 3-week calving period when cows are giving birth or have young calves with lower mobility (Cameron, Reed et al. 1992; Cronin, Ballard et al. 1994; Dau and Cameron 1986; Lawhead 1988; Lawhead, Byrne et al. 1993; Lawhead, Prichard et al. 2004). The temporal scale for construction-related impacts encompasses the duration of construction activities. Construction impacts associated with habitat loss would be permanent. The temporal scale for operational impacts is the life of the Project.

3.12.1 Affected Environment

At least 18 species of terrestrial mammals use the analysis area (Appendix E.12, *Terrestrial Mammals Technical Appendix)*, and most remain in the analysis area year-round. Because caribou are an important subsistence resource, for which NPR-A provides essential and unique habitats (e.g., TLSA) and because effects to caribou were identified as a key issue in scoping, this section focuses on caribou. Effects to other terrestrial mammals are described in Appendix E.12, but in less detail as per Council on Environmental Quality guidance (40 CFR 1500.1(b)). None of the terrestrial mammal species that use the analysis area are listed as endangered or threatened under the ESA or listed as sensitive by the BLM.

Caribou exhibit high fidelity to calving grounds and ADF&G identifies caribou herds based on calving grounds used. Two herds of barren ground caribou use the analysis area: the Teshekpuk Caribou Herd (TCH) and the Central Arctic Herd (CAH). The herds differ in their use of seasonal ranges, especially during calving, insect-relief, and during the winter (Murphy and Lawhead 2000; Person, Prichard et al. 2007).

The analysis area is primarily used by the TCH; some CAH individuals also use portions of the analysis area, but it is outside of the primary range of that herd. During summer, the TCH generally remains west of the CRD and the CAH generally remains east of the CRD (Murphy and Lawhead 2000; Prichard, Welch et al. 2018) (Figure 3.12.2). This section focuses on the TCH; information on the CAH is provided in Appendix E.12.

Seasonal density of the TCH is depicted in Figure 3.12.3. CPAI has been monitoring caribou distribution and abundance in portions of the Northeastern NPR-A annually since 2001. Surveys have covered the CRD, and the Alpine and GMT oilfields; most of the Willow area has been surveyed since 2002 (Prichard, Macander et al. 2018, 2019; Prichard, Welch et al. 2018). Surveys have not included Point Lonely or Atigaru Point. Most TCH caribou remain on the ACP between Wainwright and Nuiqsut during winter; however, approximately one-third of females (Fullman, Parrett et al. 2018), and a disproportionate number of bulls, winter in the central Brooks Range, and smaller numbers winter in western Alaska during some years (Figure 3.12.2) (Parrett 2015; Person, Prichard et al. 2007; Prichard, Welch et al. 2018).

During spring migration and the early calving season, some TCH caribou migrate through the Willow area, generally from southeast to northwest (Figure 3.12.4). Pregnant females return to the calving ground in late May or early June, barren females typically arrive later, and males arrive in mid- to late June. The highest density of calving and post-calving use occurs southeast of Teshekpuk Lake during most years (Kelleyhouse 2001; Parrett 2007; Person, Prichard et al. 2007; Wilson, Prichard et al. 2012). However, it has exhibited some annual variability since 2010, with some use of the larger area between Atqasuk and the Ikpikpuk River and other areas farther away from Teshekpuk Lake (Figures 3.12.3 through 3.12.5) (Parrett 2013; Parrett 2015; Prichard, Welch et al. 2018) and calving distribution generally farther north in years of early snowmelt (Carroll, Parrett et al. 2005) Arctic caribou calve in areas with abundant early-emerging forage plants (especially tussock cottongrass, *Eriophorum vaginatum*) that are high in protein and highly digestible (Johnstone, Russell et al. 2002; Kuropat 1984). Use of the ACP during summer appears to extend the period when caribou can find forage with adequate digestible nitrogen (Barboza, Van Someren et al. 2018).

Though caribou use a variety of habitats over the course of a year, they have specific site needs during certain seasons and life stages. Thus, though habitat used by caribou may occur throughout the ACP, seasonal site characteristics may be more limited in distribution. Wilson et al. (2012) examined factors related to calving site selection for the TCH and found that there were limited areas available with similar characteristics. However, some high-density calving has occurred to the west of Teshekpuk Lake in areas predicted to have low or moderate probability of use (Figure 3.12.3).

The TLSA was designated in 1977, pursuant to the NPRPA, and expanded in 2013 (BLM 2013a). The TLSA and its subset, the Teshekpuk Lake Caribou Habitat Area, are critical to caribou calving and insect relief for the TCH (Person, Prichard et al. 2007; Wilson, Prichard et al. 2012; Yokel, Prichard et al. 2009). The BMPs for these areas are detailed in Appendix A of BLM (2013a), and summarized below in Section 3.12.2.1, *Applicable Existing Lease Stipulations and Best Management Practices*.

Caribou behavior during summer is heavily influenced by harassment from several types of insects. Caribou distribution and behavior differs by type of insect and season. Insect harassment occurs from late June to mid-August, and TCH and CAH caribou typically exhibit the highest movement rate of the year during this period (Fancy, Pank et al. 1989; Prichard, Yokel et al. 2014). Mosquitoes emerge in mid- to late June and the area between Teshekpuk Lake and the Beaufort Sea coast is the primary mosquito-relief habitat for the TCH (Person, Prichard et al. 2007; Wilson, Prichard et al. 2012) due to generally lower temperatures and higher wind speeds. During this period, caribou repeatedly move through the narrow corridors northwest and east of Teshekpuk Lake (Yokel, Prichard et al. 2009) (Figures 3.12.4 and 3.12.6), resulting in special protections in these areas under BMP K-9 of the NPR-A IAP/EIS (BLM 2012b). (Parts of the movement corridors that are not protected by BMP K-9 are closed to oil and gas leasing.) The Southern Caribou Calving Habitat Area adjacent to the movement corridor is also protected under stipulation K-10 due to its importance for insect relief. Hence, during the mosquito season, TCH caribou are predominantly found north of the Willow area, but high densities of animals can be present in the northern portion of the analysis area.

From mid-July through early August, caribou disperse inland across the central ACP and select gravel bars, dunes, areas with residual snow, gravel roads and pads, and areas of shade created by human-made structures, including pipelines, for oestrid fly relief (Pollard, Ballard et al. 1996). Local residents hunt primarily during this period (SRB&A 2017a) and caribou density near the coast can be high (Prichard, Macander et al. 2019). Caribou movements can be rapid and unpredictable during periods of oestrid fly harassment and large numbers of caribou can be in the area near the proposed gravel roads and pads during some years. During late summer, caribou are widely dispersed and forage in order to build reserves for the rut and winter. During fall, TCH caribou are widely dispersed, and those TCH wintering in the central Brooks Range could cross the proposed gravel roads and pads while migrating south. Some caribou are likely to cross the area during non-migratory movements in the summer and winter.

The CRD marks the eastern extent of typical TCH movements during summer (Person, Prichard et al. 2007; Prichard, Welch et al. 2018; Wilson, Prichard et al. 2012). Large groups of mosquito-harassed caribou occasionally move onto the CRD in midsummer, but such occurrences are unpredictable and depend on the interplay between weather conditions and insect activity. The herd disperses inland across the central ACP during the oestrid fly and late summer seasons (Murphy and Lawhead 2000; Prichard, Macander et al. 2019; Prichard, Welch et al. 2017).

Existing development and infrastructure in the analysis area is limited. Seasonal ice infrastructure occurs annually to support oil and gas exploration; seasonal snow roads also occur annually for community access (NSB 2018b). Some gravel infrastructure in the GMT and Alpine oilfields exists, most of it closer to the CRD (Figure 3.12.1). Existing gravel infrastructure and development activities contribute dust, noise, and daily air and road traffic to the eastern portion of the analysis area, which is used for subsistence activities by local residents and research activities.

3.12.2 Environmental Consequences

3.12.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.12.1 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate impacts to caribou from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to caribou habitat, subsistence hunting areas, and the environment, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.12.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Caribou

LS or BMP	Description or Objective	Requirement
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP C-1	Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.	Cross-country use of heavy equipment is prohibited within one-half mile of occupied grizzly bear dens or within 1 mile of known or observed polar bear dens or seal birthing lairs.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Bulldozing of tundra mat and vegetation, or trails is prohibited. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.

LS or BMP	Description or Objective	Requirement
BMP E-19	Provide information to be used in monitoring and assessing wildlife movements during and after construction.	A representation, in the form of ArcGIS-compatible shapefiles, of all new infrastructure construction, shall be provided to the authorized officer.
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Land user shall submit an aircraft use plan as part of an oil and gas development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area should be minimized from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as aircraft approach the aircraft is too close and must break away.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.

LS or BMP	Description or Objective	Requirement
BMP K-5	(Teshekpuk Lake Caribou Habitat Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.	Design, implement, and report a study of caribou movement. The study shall include a minimum of four years of current data on the Teshekpuk Caribou Herd movements. Within the Teshekpuk Lake Caribou Habitat Area, permittee shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. A number of ground and air traffic restrictions are specified, including but not limited to: Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter. The permittee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20.
LS/BMP K-6	Protect coastal waters and their value as fish and wildlife habitat, minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas…and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites.
BMP K-9	(Teshekpuk Lake Caribou Movement Corridor) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.	Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources.
BMP K-10	(Southern Caribou Calving Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake.	Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or other infrastructure associated with offshore oil and gas production, will be allowed.

LS or BMP	Description or Objective	Requirement
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities	On a case-by-case basis, BLM may permit lowground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Best Management Practice C-2a.
BMP M-1	Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control.

Source: BLM 2013a

Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska); USGS (U.S. Geological Survey)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect caribou would include those to LS E-2 and BMPs E-5 and E-7. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also place new VSMs along existing pipeline corridors due to pipe rack capacity limits (deviation to BMP E-5); all alternatives would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip; and under Alternative C, the Willow processing facility would not be colocated with a drill site pad.

Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7), due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site pad or at narrow land corridors between lakes where it is not possible to maintain 500 feet separation between pipelines and roads without increasing potential impacts to waterbodies. Caribou may experience more delays or deflections while crossing roads and pipelines in these locations where the separation is less than 500 feet.

3.12.2.2 Alternative A: No Action

Under the No Action Alternative, seasonal ice roads and pads could continue to be built in the analysis area. Effects from the existing development at Alpine and GMT oilfields would continue, including air and road traffic.

3.12.2.3 Alternative B: Proponent's Project

3.12.2.3.1 Habitat Loss or Alteration

Project activities with the potential to cause habitat loss or alteration include the following:

- Fill for new gravel roads and pads
- Gravel spray and dust deposition from roads and pads
- Altered drainage patterns adjacent to gravel and ice infrastructure
- Delayed melt of snow in drifts, compressed snow, and ice from ice infrastructure
- Gravel mining and mine rehabilitation

Alternative B would permanently remove 656.6 acres of terrestrial mammal habitat due to gravel fill and gravel mining. Tables E.12.5 and E.12.6 in Appendix E.12 summarize habitat loss or alteration by habitat type and alternative. The mine site pit (whether connected to nearby streams during reclamation or not) would permanently fill with water and be unsuitable for terrestrial mammals. Because the habitats lost are not unique and occur throughout the analysis area and ACP, caribou would likely move to similar habitats nearby.

Use of gravel infrastructure would result in gravel spray and dust deposition, which would alter 3,312.1 acres of terrestrial mammal habitats within 328 feet (100 m) of gravel infrastructure (3,076.0 acres in high use habitats). Dust can change plant community composition or structure and is discussed in detail in Section 3.9, *Wetlands and Vegetation*. These changes to habitat would vary by habitat type and topography and could degrade forage quality for caribou.

Gravel and ice infrastructure could also change drainage patterns and create impoundments that would alter habitats immediately adjacent to gravel infrastructure. Impoundments can be caused by physically blocking drainage and by early snowmelt due to dust deposition adjacent to gravel infrastructure. If impoundments lasted more than one season, they could cause thermokarst and permanently alter habitats adjacent to gravel infrastructure (impoundments are described in Section 3.8, *Water Resources*).

Compressed snow and ice from ice infrastructure and from snow removal on gravel roads would temporarily alter habitats by delaying snowmelt and damaging vegetation. These changes to habitat (discussed in detail in Section 3.9) would vary by habitat type and topography and could degrade forage quality for caribou.

3.12.2.3.2 Disturbance or Displacement

Project activities that could potentially disturb or displace terrestrial mammals include the following:

- Increased human activity and noise from construction, pile driving, mining, equipment use, flaring, and drill rigs, as well as ground and air traffic that could cause avoidance.
- New linear infrastructure and visual disturbance, such as pipelines and roads, that could result in some delays or deflections of movement.
- Increased subsistence access due to Project roads.

Behavioral disturbance can cause immediate responses in caribou, including startle or flight responses (Murphy, Russell et al. 2000; Reimers and Colman 2009). Behavioral disturbance may also result in displacement or long-term reduction of use in areas experiencing constant human activity or noise (Nellemann, Vistnes et al. 2003), especially for females during calving. The degree of behavioral disturbance of caribou can vary depending on season, life stage, mobility of calves, and effectiveness of mitigation (Cronin, Ballard et al. 1994; Murphy and Lawhead 2000).

As previously described (and cited above), the analysis area was selected because a decreased density of maternal caribou has been documented within a zone of localized displacement variously reported to range from 0.6 mile to 3.7 miles (1 to 6 km) of active roads and pads during calving and for 2 to 3 weeks immediately after calving. This body of research indicates a consistent displacement zone of 1.25 to 2.5 miles (2 to 4 km) wide; thus, the area within 2.5 miles (4 km) of new gravel infrastructure was used to calculate caribou displacement from the Project.

Human activity associated with Alternative B would disturb or displace caribou across 121,469.1 acres. The disturbance zone would be located in areas where the average caribou calving density is in the low end of the range (0.3 to 1 total caribou per square km) from 2002 through 2018 based on aerial surveys (Figures 3.12.3, 3.12.5, and 3.12.6). The area within 2.5 miles of Alternative B contains between 0.32% and 1.57% of the seasonal range of the TCH (females only) based on **kernel distribution** (Figure 3.12.3; Table E.12.7 in Appendix E.12). This equates to roughly 176 to 864 caribou of the 55,614 herd estimate from July 2017 (Klimstra 2018). Because caribou move frequently during the season, a larger percentage of caribou could be within this buffer over the course of a season. Though displacement could occur (Cameron, Reed et al. 1992; Dau and Cameron 1986), complete avoidance of areas with human activity does not appear to occur, and some maternal females are presumably less susceptible to human disturbance. The stimulus for this effect appears to be human activity rather than the presence of infrastructure alone; the effect even occurs along roads with relatively low levels of traffic at or below normal operational levels (Dau and Cameron 1986; Lawhead 1988; Lawhead, Prichard et al. 2004), but caribou exhibit less displacement of areas near infrastructure with no activity (Lawhead, Prichard et al. 2004). Thus, except perhaps for a small proportion of the most tolerant females, maternal caribou with young calves do not habituate to road traffic. Displacement would occur during and immediately after the calving season, for about 3 weeks, in every year throughout the life of the Project. The magnitude of this displacement would depend on the number of caribou displaced and the availability of alternate suitable habitat. Wilson et al. (2012) found a limited availability of calving areas with similar characteristics. However, in recent years, moderately high levels of calving occurred to the west of Teshekpuk Lake, in areas predicted to have low or moderate probability of use (Figure 3.12.3).

During the mosquito and oestrid fly seasons (late June to mid-August), CAH caribou of all ages and both sexes regularly approach and cross pipeline or road corridors while moving to and from insect-relief habitat (Curatolo and Murphy 1986; Murphy and Curatolo 1987; Murphy and Lawhead 2000). Crossing success at linear pipeline-road corridors is lowest when caribou groups attempt to cross pipelines near roads (within 300 feet) or where traffic rates exceed 15 vehicles per hour (Curatolo and Murphy 1986; Lawhead, Byrne et al. 1993; LGL Alaska Research Associates Inc. 1994). Deflected movements and delays in crossing of up to several hours are common under these circumstances (Johnson and Lawhead 1989; Lawhead, Byrne et al. 1993). Project roads would be 500 to 1,000 feet from pipelines whenever possible. During construction (winter 2021 through 2027), traffic rates are estimated to exceed 68.0 vehicles per hour; thus, deflections and delays in movement could occur. From 2028 through 2032, traffic rates would be reduced (estimated 11.9 one-way trips per hour), and caribou deflections would occur less frequently and be of lower intensity. From 2033 through 2050, traffic rates would be further reduced (estimated 7.4 trips per hour). Project design also includes elevating pipelines to a minimum height of 7 feet at VSMs, 2 feet higher than has been demonstrated to be adequate to maintain crossing success for CAH caribou during the snow-free season (Lawhead, Parrett et al. 2006). Few TCH caribou are expected to be in the Project area during the mosquito season, lowering the potential for adverse effects on movements during this period.

Caribou tend to follow linear infrastructure when structures are oriented roughly parallel to their main direction of movement (Murphy and Anderson 1993; Smith, Byrne et al. 1993). Large groups of TCH caribou could also move through the analysis area in response to weather conditions during the oestrid fly season. The Alternative B infield road could funnel caribou movement along the west side of the road and toward the airstrip and WPF during fall migration south and non-migratory movements during summer.

Noise would be greatest during winter construction, especially near bridges with piles (where impact hammers would be used) and around the mine site, where blasting and gravel hauling would occur. Blasting, although of very short onset and duration, would produce the loudest sound levels of the Project. This human activity and noise would disturb and displace caribou from around the mine site.

Ground and air (helicopters and fixed-wing aircraft) traffic noise would also disturb or displace caribou throughout the life of the Project. Effects of ground traffic (noise and human activity) along roads are described above. Ground traffic would be highest near the WOC, WPF, and airstrip. Air traffic noise would be greatest at airstrips and when animals are directly under low-flying aircraft. The magnitude of disturbance to caribou would be greatest during calving. The majority of flights to the Project airstrip would originate from Alpine (Figure 3.6.1 in Section 3.6, *Noise*), and flight paths would not cross medium- or high-density caribou areas during calving. Low-level aircraft traffic over calving grounds and early post-calving aggregations have been reported to reduce calf survival (Harrington and Veitch 1992), though these results were based on small sample sizes and may have been confounded by herd differences (Reimers and Colman 2009). Prolonged exposure to low-level aircraft could increase daily energy expenditure and potentially decrease individual fitness or reproductive capacity; however, caribou can become habituated to aircraft and as a result exert minimal additional energy in response to aircraft (Webster and Young 1997). The eastern analysis area experiences existing air traffic to and from Nuiqsut; GMT-2, which is currently under construction and will have weekly air traffic through construction. Air traffic from Alternative B would not pass over the TLSA calving grounds, or high-density post-calving areas; air traffic would be limited to low- and no-density caribou calving areas (the Alternative B airstrip would be in a low-density calving area, Figure 3.12.5). More air traffic would occur during construction, would continue through operations, and could occur year-round (Table E.11.8 in Appendix E.11, *Birds Technical Appendix*).

Increased subsistence access due to Project roads could change caribou distribution and movements and exacerbate the response of caribou to roads and traffic. Although only a small portion of the TCH range would be exposed to increased hunting, if more hunters are in the area, caribou could move farther away from Project infrastructure and may be less likely to habituate to roads and traffic (Paton, Ciuti et al. 2017; Plante, Dussault et al. 2018). The anticipated increased access and harvest is described in Section 3.16, *Subsistence and Sociocultural Systems*.

3.12.2.3.3 Injury or Mortality

Terrestrial mammals could be injured or killed due to collisions with vehicles or from increased subsistence access (and presumably harvest).

The addition of new roads and airstrips, and increased use of vehicles during construction and operation would increase the potential for vehicle strikes. Such accidents could occur during all Project phases but would be greatest during mid- to late summer (July through August), when large numbers of insect-harassed caribou are present, and some are attracted to Project infrastructure while seeking fly relief. At such times, caribou often are less cautious around vehicles. The risk of vehicle strikes would be greatest during the construction and drilling phases, when traffic rates would be highest. Scheduling the heaviest construction-related traffic during the winter, employing environmental and safety training, and mandating that all drivers yield the right-of-way to wildlife would help reduce the potential for vehicle strikes. Injury of caribou from collisions would be unlikely to cause population-level effects.

Dust along roads could cause early snowmelt and early green-up on tundra adjacent to gravel infrastructure (Walker and Everett 1987); though this could provide early foraging opportunities, it could also increase the potential for vehicle strikes of caribou that feed in the dust shadow of gravel roads in spring.

Collision rates for terrestrial mammals in the Alpine and GMT developments from 2015 to June 2019 ranged from 1 to 5 collisions per year. Collisions were mostly with foxes, and 1 wolverine; no collisions with caribou were reported. Increased subsistence access and presumably harvest due to Project roads could increase mortality of caribou in the analysis area. Though it is unknown how many hunters would use Project roads, just over half of **households** (54%) in Nuiqsut reported using roads in the GMT and Alpine area to hunt caribou in 2018 (as detailed in Section 3.16.2.3.3, *Harvester Access*, in Section 3.16, *Subsistence and Sociocultural Systems*).

3.12.2.3.4 Attraction to Human Activities and Facilities

During the mosquito season, large groups of caribou may be deflected or delayed when traffic rates are high (i.e., more than 15 vehicles per hour) (Lawhead, Byrne et al. 1993; Lawhead and Flint 1993). However, during oestrid fly harassment, caribou may be attracted to gravel infrastructure (where vegetation and thus insects are fewer) as fly-relief habitat (Curatolo and Murphy 1986; Johnson and Lawhead 1989; Lawhead, Byrne et al. 1993; Noel, Pollard et al. 1998). At such times, groups of caribou would likely seek relief (and/or travel) in the elevated Project gravel roads and pads and shaded or sheltered areas (including elevated pipelines, VSMs, buildings, etc.). During these times, groups numbering in the hundreds or even thousands may move onto Project gravel roads and pads until oestrid fly harassment subsides. These effects would be both positive (relief from fly harassment) and negative (increased risk of vehicle strikes on roads). Alternative B would have 442.7 acres of gravel roads and pads, and 93.2 miles of new pipeline racks (on new VSMs) that may be used by caribou for insect relief.

3.12.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described under Alternative B, with the following differences. Alternative C would locate the WPF, WOC, and southern airstrip further east to an area with lower densities of caribou. Because fewer caribou use this area, disturbance and displacement due to noise and human activity from these facilities would affect fewer caribou. The alternative would decrease the potential for deflection of migrating caribou, especially near Lake M0015, because it would remove the perpendicular intersection of access and infield roads, which could be a pinch-point for caribou movement. The elimination of the section of road near Judy Creek would make east-west movements of caribou easier.

Because Alternative C would also move the southern airstrip to the east, caribou would be less likely to be funneled into the area by the infield road. The area within 2.5 miles of Alternative C contains between 0.33% and 1.64% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.8 in Appendix E.12), which is a similar proportion of the herd as Alternative B.

Alternative C would also remove 41.5 more acres of habitat due to gravel fill and gravel mining and alter 56.6 more acres of habitat due to the dust shadow. (Tables E.12.5 through E.12.7 in Appendix E.12 detail habitat loss and alteration by habitat type and alternative.) Alternative C would have fewer gravel roads and the least amount of ground traffic of any action alternative (i.e., the least amount of disturbance and potential vehicle strikes) over the life of the Project. Lower ground traffic rates and less hunting on the northern infield road could increase the probability of caribou habituating to infrastructure during some seasons.

Alternative C would also have an additional airstrip and personnel camp that would result in more air traffic (both fixed-wing and helicopter) and more hazing of wildlife at the airstrips, especially in summer, which would disturb or displace caribou over an additional area. Traffic rates are detailed in Table E.11.8 in Appendix E.11. There would be 4,174.7 additional acres of disturbance under Alternative C. Because the north airstrip in Alternative C would be located closer to the high-density calving areas for the TCH, aircraft traffic is likely to disturb more caribou during the calving season. During takeoff and landing, air traffic (which could include large aircraft [e.g., DC-6; C-130]) at the northern airstrip would be perpendicular to the northern infield road, which would likely disturb or displace caribou beyond the 2.5-mile area of displacement from roads and pads. Because the northern infield road would be disconnected from the access road, use of the northern infield road by subsistence hunters would be unlikely in the summer. Thus, that area would experience a lesser degree of hunting pressure, which would likely lower the degree of disturbance and displacement and may result in a higher level of habituation to the road. Caribou would also be less likely to be shot if hunting is allowed on fewer road miles. However, if caribou are hunted along a nearby road, they may associate all roads with hunting, and this effect would be diluted. Winter ice road access to the northern infield road for subsistence hunting would still occur.

There would also be one additional season of ice roads during construction as well as an annual ice road (3.9 miles) required for the life of the Project, which could have longer lasting effects on disturbance and displacement of caribou in winter.

Alternative C would have 1.1 more miles of new pipeline racks (on new VSMs) that may be used by caribou for oestrid fly relief.

3.12.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described under Alternative B, with the following exceptions. Alternative D would have a decreased potential for deflection of migrating caribou, especially near the WPF, since it would remove the perpendicular intersection of access and infield roads. Caribou moving south along the east side of the infield roads during southerly movements in the fall would not have to cross a road, which would lower the probability of delays or deflections. The area within 2.5 miles of Alternative D contains between 0.31% and 1.41% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.8 in Appendix E.12), which is a similar proportion of the herd as Alternative B.

Alternative D would have 30.6 fewer acres of habitat removed from gravel fill and 716.3 fewer acres of habitat altered by the dust shadow. (Tables E.12.5 through E.12.8 in Appendix E.12 details habitat loss and alteration by habitat type and alternative.) Alternative D would have 9.9 fewer miles of gravel roads and thus have 14,062.8 less acres of disturbance (acres calculated by gravel road disturbance), but there would be more ground traffic over the life of the Project. Traffic rates are detailed in Table E.11.8 in Appendix E.11. Alternative D would have the most ground and air traffic of any action alternative. Air traffic (both fixed-wing and helicopter) would be elevated, especially in summer, which would disturb or displace caribou over an additional area. Because the infield road would be disconnected from the access road, use of the infield road in summer and fall by subsistence hunters would be unlikely, although some hunting may occur during winter, and that area may experience a lesser degree of hunting pressure, which would influence caribou distribution and habituation, as described under Alternative C.

There would also be two additional seasons of ice roads during construction and an annual ice road (9.8 miles) required for the life of the Project, which could have longer lasting effects on disturbance and displacement of caribou in winter.

Alternative D would have 1.0 fewer mile of new pipeline racks (on new VSMs) that may be used by caribou for insect relief.

3.12.2.6 Module Delivery Options

Some effects on caribou from module delivery options are similar to those described for land-based alternatives. Effects that would be unique to the marine area are detailed below. All module delivery options would include ice road transport of sealift modules during winter. The types of effects from ice roads are described above for Alternative B. The intensity and context of the effects may differ and are described below. The ice roads for all module delivery options would be within the TLSA.

3.12.2.6.1 Option 1: Proponent's Module Transfer Island

Similar types of disturbance or displacement of caribou as described in Alternative B would also occur from the MTI. The magnitude of effects would be less because the island would be 2.4 miles offshore and caribou do not use offshore habitat. It is possible that individual caribou along the coastline may be disturbed by construction offshore in winter or summer, use of the area by the TCH occurs throughout the year but is highest during mid- to late summer (Figures 3.12.3 and 3.12.5). There would be a multi-season ice pad at Atigaru Point for storage of equipment, but no air or ground traffic to it during the summer. Construction activity at the MTI could occur from July 7 through September 30. The area within 2.5 miles of the MTI contains between 0.01% and 0.04% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.8 in Appendix E.12).

There would be a total of 109.9 miles of onshore ice road (23.2 miles within the boundary of the TLSA). This would impact forage (damage vegetation) and would disturb caribou (effects of ice roads are described under Alternative B). However, disturbance would occur in winter when displacement is unlikely to be as strong as during the calving season. TCH animals have already been exposed to winter ice roads in this area and may have habituated to some degree. There would also be 50 flights to Alpine and 150 to Willow during construction or decommissioning of the MTI and to support module mobilization. Ground and air traffic rates are detailed in Tables E.11.9 to E.11.11 in Appendix E.11.

3.12.2.6.2 Option 2: Point Lonely Module Transfer Island

Similar types effects to caribou as described for Option 1 would occur for Option 2. However, there are stark contrasts in the magnitude and intensity of the effects between the two options.

The location of Point Lonely is closer to Teshekpuk Lake and nearly double the distance to the Willow area. The Teshekpuk Lake area is critical to caribou calving, post-calving, mosquito-relief, and oestrid fly-relief uses. Point Lonely is 2.4 miles from the high-density area for post-calving use, and in the high-density area for mosquito- and oestrid fly–relief use (Figures 3.12.3 and 3.12.5). (Point Lonely has low caribou density during calving and winter.)

Point Lonely is an area of high use by caribou for insect relief (end of June to beginning of Aug). Project activities in summer could occur from July 7 through September 30 and could disturb caribou during this period. The area within 2.5 miles of the Point Lonely MTI (and the existing gravel infrastructure that would be used during construction) contains between <0.01% and 0.79% of the seasonal range of the TCH (females only) based on kernel distribution (Figure 3.12.3; Table E.12.8 in Appendix E.12).

The MTI for Option 2 would also be 0.6 mile from shore, whereas the MTI for Option 1 would be 2.4 miles from shore, so any activity at the Option 2 MTI could disturb more caribou, especially in July.

Due to the Project's distance from the Willow area, it would have double the ice road miles compared to Option 1. There would be a total of 227.9 miles of onshore ice road (105.4 miles within the boundary of the TLSA). This would result in more impact on forage (vegetation damage) and more area of caribou disturbance. Disturbance would occur in winter when displacement is unlikely to be as strong as during the calving season. Option 2 would have more total ground traffic trips than Option 1 (Tables E.11.9 to E.11.11 in Appendix E.11).

Option 2 would also use existing gravel infrastructure onshore at Point Lonely during construction. Onshore summer activities would include creation of a personnel camp on existing gravel pads, air traffic, onshore beach landings of crew boats to and from the MTI, and equipment use on the airstrip and pads (to distribute additional gravel that would have been transported to the pads in the winter). There would be a total of 90 flights to the Point Lonely airstrip, 30 of these would occur in the summer, which would equal 1 to 2 flights per week over 6 to 12 weeks during three summer construction seasons (2022, 2023, and 2025). Option 2 would have 120 additional fixed-wing flights as Option 1. Air traffic is detailed in Tables E.11.9 to E.11.11 in Appendix E.11. The air traffic for Option 2 would cause markedly more disturbance of caribou than Option 1.

For these reasons (location in insect relief habitat, closeness to shore, and human activity and air traffic onshore), Option 2 would result in more disturbance and displacement of caribou than Option 1.

3.12.2.7 Oil Spills and Accidental Releases

The EIS addresses effects from accidental spills. As described in Chapter 4.0, *Spill Risk Analysis*, the likelihood of a large spill during any phase of the Project would be very low. A very small to small spill or leak would be probable over the life of the Project and would most likely occur on gravel infrastructure, where it would be easier to contain and remediate than a spill on undisturbed tundra. Since caribou may use gravel infrastructure during the insect season, effects from spills on gravel may still occur.

Spills that may originate along pipelines would be expected to be detected and responded to quickly, although they would potentially have a larger geographic extent than spills on pads. In the very unlikely event that a pipeline spill should occur at a river crossing during high water flow, the geographic extent of the accidental release could be larger. A spill could alter mammal habitat, and effects would vary depending on the location and size of the spill and the time of year. The spill itself and cleanup activities would disturb and displace mammals due to noise and human activity.

Spills of hydrocarbons and other fluids degrade terrestrial mammal habitats by physically covering vegetation, thawing permafrost, and exerting toxic effects on plants and animals. Exposure to and ingestion of contaminants (including minor incidents of fouling and oiling) in the North Slope oil fields has occasionally resulted in injury and mortality to small numbers of animals (Amstrup, Gardner et al. 1989).

Seawater spills on nonfrozen tundra would have effects on plants used by caribou for forage that could potentially last many years. Saltwater spills can be toxic to many plant species, long lasting, and can cause leaf deterioration and deleafing (Simmons 1983). Wetter sites recover more rapidly. Willow species (*Salix* spp.) and mountain avens (*Geum* spp.) have a lower tolerance for salt and are more affected, while grasses and sedges are less affected (Simmons 1983).

3.12.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. BMP E-7 describes requirements related to caribou ramps over pipelines or buried pipelines. The Project could designate specific locations for these, such as northeast of the airstrip in Alternative B. The decision to add a crossing ramp over a buried pipeline should consider potential negative effects of reduced access to the pipeline for oil spill detection and response and thermokarst or changes in surface flow due to the resulting long-linear ditch that would fill with water.

3.12.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with LSs, BMPs, and mitigation measures in place, some unavoidable impacts to caribou would occur including direct loss of habitat and disturbance and displacement due to noise, human activity, infrastructure, or increased subsistence access. These impacts would be irretrievable throughout the life of the Project but would not be irreversible or affect the long-term sustainability of wildlife in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.13 Marine Mammals

The analysis area for onshore activities for marine mammals is the area within 1 mile of onshore construction and operation activities and within 1.5 miles of construction activities and support vessel route for offshore construction (Figure 3.13.1). This area represents the maximum distance that underwater or airborne noise or vibration could affect marine mammals and their habitats (based on the USFWS polar bear den disturbance zone), and also represents the maximum distance from which polar bears may be attracted to Project facilities.

The temporal scale for construction impacts is the duration of construction because most construction impacts are related to noise and human activity. The temporal scale for operational impacts is the life of the Project, or until reclamation is complete. Reclamation of onshore areas can take many years, depending on the tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. Marine substrates that would be screeded are expected to return to pre-screeding condition in approximately one season. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.5.1, *Option 1:* Proponent's *Module Transfer Island,* in Section 3.8, *Water Resources*).

3.13.1 Affected Environment

The analysis area includes existing oil and gas infrastructure (gravel and ice roads, processing facilities, etc.) as part of the Alpine and GMT oilfields and associated daily aircraft traffic. There is no existing infrastructure in Harrison Bay or near Point Lonely; marine habitat is generally undisturbed. Coastal waters off the NPR-A have pristine water quality (BLM 2012b). The marine environment is detailed in Section 3.8.

A list of species that may be present in or near the analysis area, including species currently listed as threatened or endangered under the ESA are presented in Table 3.13.1. The MTI is located outside of the known range of several marine mammal species; therefore, these species are not discussed further in the analysis.

Table 3.13.1. Marine Mammals Known to Occur in the Analysis Area

Common Name	Scientific Name	ESA Status	Included in Analysis
Polar bear	*Ursus maritimus*	ESA threatened	Yes
Bowhead whale	*Balaena mysticetus*	ESA endangered	No, migration corridor outside of analysis area
Beluga whale	*Delphinapterus leucas*	Not applicable	No, migration corridor outside of analysis area
Bearded seal	*Erignathus barbatus*	ESA threatened	Yes
Ringed seal	*Pusa hispida*	ESA threatened	Yes
Spotted seal	*Phoca largha pallas*	Not applicable	Yes
Ribbon seal	*Histriophoca fasciata*	Not applicable	No, not likely to occur in analysis area

Note: ESA (Endangered Species Act)

3.13.1.1 Special Status Species

Three special status species in Table 3.13.1 may occur in the analysis area. Only polar bears have designated **critical habitat** in the analysis area (Figure 3.13.1). More information about special status species is found in Appendix E.13, *Marine Mammals Technical Appendix*.

Polar bears in the analysis area are the Southern Beaufort Sea stock, which spends a majority of the year near the coast and moves further offshore to pack ice during the summer (Durner, Amstrup et al. 2004). They use terrestrial habitat for maternity denning, scavenging, resting, and travel between marine habitats (Regehr, Hunter et al. 2010). Potential terrestrial denning habitat is defined as a topographic feature at least 4.3 feet in height and having at least an 8-degree slope, which provides conditions for drifting snow (Durner, Simac et al. 2013). There are approximately 3,126.6 acres of potential terrestrial denning habitat in the analysis area. The nearest known polar bear maternal dens are approximately 3 miles from proposed gravel infrastructure (in this case, the HDD pads) for all action alternatives, and less than 0.1 miles from the proposed ice road for the module delivery options (Durner et al. 2010; USGS unpublished data) (Table E.13.5 in Appendix E.13).

Bearded seals in Alaska are of the Pacific sub-species and members of the Beringia distinct population segment; they are listed as threatened and have no designated critical habitat. They may be present in the analysis area throughout the year in areas of shallow water (less than 650 feet) that are at least seasonally ice covered (Cameron, Bengtson et al. 2010). Ringed seals are listed as threatened, and critical habitat has been proposed but not designated. They are likely to be present in the analysis area in waters between 15 to 115 feet deep (Frost, Lowry et al. 2000) and near bottom-fast ice where they can overwinter (Kelly, Badajos et al. 2010).

3.13.1.2 Spotted Seals

Spotted seals may be seasonally present in the analysis area along the coast of Harrison Bay and in the CRD (BLM 2012b) during winter and spring near sea ice (Quakenbush 1988), using terrestrial haul-outs on mud, sand, or gravel beaches, and on sea ice in the spring where water depth does not exceed 650 feet (Muto, Helker et al. 2018). During winter and spring, this species is strongly associated with the presence of sea ice (Quakenbush 1988).

3.13.2 Environmental Consequences

Under the Marine Mammal Protection Act, the NMFS and the USFWS have defined levels of harassment for marine mammals. Level A harassment is defined as the potential to injure, and Level B harassment is defined as the potential to disturb. Appendix E.13, details noise thresholds for marine mammals and provides general information on noise.

3.13.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.13.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate impacts to marine mammals from development activity (BLM 2013a). The LSs and BMPs would reduce impacts to marine habitat, subsistence hunting areas and the environment, associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.13.2. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Marine Mammals

LS or BMP	Description or Objective	Requirement
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.

LS or BMP	Description or Objective	Requirement
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear-interaction plans to minimize conflicts between bears and humans.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring, emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures.
BMP C-1	Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.	Cross-country use of heavy equipment is prohibited within one-half mile of occupied grizzly bear dens, and within 1 mile of known or observed polar bear dens or seal birthing lairs.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.
BMP E-19	Provide information to be used in monitoring and assessing wildlife movements during and after construction.	A representation, in the form of ArcGIS-compatible shapefiles, of all new infrastructure construction, shall be provided to the authorized officer.

LS or BMP	Description or Objective	Requirement
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Fixed wing aircraft used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 2,000 feet when within a ½-mile of walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Aircraft used as part of a BLM-authorized activity along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
LS/BMP K-1	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals); protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated; vessels will maintain 1-mile buffer from aggregation of hauled out seals and half-mile buffer from walruses.
BMP M-1	Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NPR-A (National Petroleum Reserve in Alaska

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect marine mammals would include those to BMPs E-5 and K-1. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in BMP K-1) (Figure 3.10.2 in Section 3.10, *Fish*). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also place new VSMs along existing pipeline corridors due to pipe rack capacity limits (deviation to BMP E-5); all alternatives would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip; and under Alternative C, the Willow processing facility would not be colocated with a drill site pad.

3.13.2.2 Alternative A: No Action

Under Alternative A, there would be no impacts on marine mammals as the result of the Project; however, existing oil and gas activities and exploration in the area would continue, as would existing impacts on marine mammals from air and ground traffic and human presence.

3.13.2.3 Alternative B: Proponent's Project

3.13.2.3.1 Habitat Loss or Alteration

Approximately 0.6 acres of polar bear potential terrestrial denning habitat would be removed under Alternative B (Figure 3.13.2). Ice infrastructure would cover 2,872.3 acres, which could alter foraging habitat during winter construction. Altered habitat from the construction of single season ice roads and pads would recover almost immediately after the winter season is complete and the ice melts. Multi-season ice pads could take longer to recover depending on the degree of soil saturation as detailed in Section 3.9, *Wetlands and Vegetation*. Approximately 442.7 acres of foraging habitat for polar bears would be permanently lost as a result of gravel infrastructure. There would be no operational impacts to other marine mammals, as all facilities, roads, drill sites, pads, and other Project components are located inland.

3.13.2.3.2 Disturbance or Displacement

All construction and operational activities may result in disturbance or displacement of marine mammals from noise or from the physical presence of equipment or personnel.

Construction of ice and gravel infrastructure, pile driving, and increased ground and air traffic could disturb (and locally displace) seals and polar bears due to airborne noise and the physical presence of humans and equipment. Denning females are more sensitive to disturbance; using the disturbance buffer of 1 mile commonly used by USFWS for identified polar bear dens, 853.5 acres would potentially be disturbed. Using the estimated distance of 200 feet to the NMFS airborne disturbance threshold, the potential disturbance for seals on ice is 2.9 acres. The duration and frequency of impacts from construction would be continuous during construction and operation. Because activities would have a short duration and occur over a small area of denning and critical habitat relative to the entire North Slope, polar bears and seals are expected to find alternate similar habitat. Implementation of BMPs would lessen (not eliminate) impacts from disturbance and displacement.

Increased presence of human activity and infrastructure would potentially disturb polar bears. Using the disturbance buffer of 1 mile for polar bear dens during operations, 85.3.5 acres would potentially be disturbed. There would be no impacts to seals, as all facilities are located inland.

Increased air traffic can cause noise disturbances for all marine mammals if presence of air traffic is under 1,500 feet over water or haulout sites (including during landing or takeoff). Flights during winter and early spring would mostly affect polar bears and ringed and bearded seals, especially over known maternal polar bear dens (Figure 3.13.1) and seal haulout sites. Flights occurring during late spring and the open-water season could impact all species of marine mammals in the analysis area. The portion of the analysis area near the GMT development experiences a higher amount of weekly aircraft traffic than other areas on the North Slope, and an incremental addition of air traffic there is unlikely to be detected by marine mammals. Exposure of marine mammals to aircraft presence would occur throughout the life of the Project, but each occurrence would be temporary and of short duration and would result in brief behavioral responses. Population-level effects would not occur.

3.13.2.3.3 Injury or Mortality

Noise from construction activities, such as pile driving, may result in Level A harassment (Table E.13.2 in Appendix E.13). Standard mitigation measures would be implemented to reduce the likelihood of Level A harassment, such as shutting down if a marine mammal enters the analysis area. There is a potential for noise and/or physical presence to cause female bears searching for den locations to be displaced or abandon a den with cubs.

Impacts to marine mammals as a result of injury or mortality from vessel collision is not expected; therefore, the extent and duration that injury or mortality would occur is not included in this analysis.

Polar bears are curious and opportunistic hunters that frequently approach and investigate locations where human activity occurs (LGL Ecological Research Associates 1993; Stirling 1988). Proximity to humans poses risks of injury or mortality for both bears and humans and may necessitate nonlethal take through deterrence and hazing or, on rare occasions, lethal take to defend human life (LGL Ecological Research Associates 1993; Perham 2005; Stenhouse, Lee et al. 1988).

As sea-ice cover in the Arctic continues to diminish in the future, the number of encounters between nutritionally stressed bears and humans is expected to increase (DeBruyn, Evans et al. 2010). Despite the increase in human-bear interactions in the existing oil fields in recent years, virtually no lethal take or injuries of polar bears have been reported (USFWS 2008b, 2009, 2016).

Air emissions would not exceed the National Ambient Air Quality Standards (NAAQS), and thus would not be harmful to people and polar bears.

3.13.2.4 Alternative C: Disconnected Infield Roads

The extent and types of impacts to marine mammals under Alternative C would be similar to those described for Alternative B, with the following exceptions. There would be 45.1 more acres of habitat loss and potential for disturbance for polar bears; 528.0 more acres covered by ice infrastructure (habitat alteration); 470 more fixed-wing airplane trips; and 547 more helicopter trips (Table E.11.8 in Appendix E.11, *Birds Technical Appendix,* for traffic details). There would be one additional season of ice roads during construction, as well as an annual ice road (3.9 miles) required for the life of the Project, which could have longer lasting effects on habitat and could result in more potential disturbance.

3.13.2.5 Alternative D: Disconnected Access Road

The extent and types of impacts to marine mammals under Alternative D would be similar to those described for Alternative B, with the following exceptions. There would be 32.0 fewer acres of habitat loss due to gravel fill; 1,578.9 more acres would be covered by ice infrastructure (habitat alteration); and 9,685 more fixed-wing airplane trips; and 2,180 more helicopter trips (Table E.11.8 in Appendix E.11 for traffic details). There would be two additional seasons of ice roads during construction, as well as an annual ice road (9.8 miles) required for the life of the Project, which could have longer-lasting effects on habitat and could result in more potential disturbance.

3.13.2.6 Module Delivery Options

Some of the types of effects to marine mammals from module delivery options would be similar to those described above for the land-based alternative. Effects that would be unique to the marine area are summarized below and detailed in Tables E.13.5 and E.13.6 in Appendix E.13.

3.13.2.6.1 Option 1: Proponent's Module Transfer Island

Gravel fill for the MTI would permanently remove 12.8 acres of marine habitat (designated as polar bear critical habitat) in approximately 8 to 10 feet water depth. The MTI area currently has no human development and is predominantly composed of fine silt and clay substrates (Kinnetic Laboratories Inc. 2018). The MTI would alter existing substrates by adding gravel and gravel bags. After abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.5.1, *Option 1: Proponent's Module Transfer Island,* in Section 3.8, *Water Resources*). The gravel would be naturally redistributed by wind and waves, which would alter the substrate of surrounding habitats. Habitat alteration would also occur from increased suspended sediment (across 11 to 15 acres) during construction of the MTI and from screeding (4.9 acres). Marine substrates that would be screeded are expected to return to pre-screeding condition in approximately one season.

Disturbance and displacement would occur from on-ice work in winter and in-water work in summer, and from vessel traffic. Underwater and airborne noise would be created from equipment and marine vessels. Seals may temporarily be displaced from marine waters during construction, but ringed seals exhibit tolerance to construction (Moulton, Richardson et al. 2003). During construction, the estimated distance to the NMFS underwater disturbance threshold for seals ranges from less than 600 feet for backhoes or bulldozers (resulting in 2 to 24 acres of disturbed area). The estimated distance to the airborne disturbance threshold is approximately 200 feet, resulting in 2.9 acres of disturbed area. Using a 0.5-mile exclusion zone commonly used by the USFWS for polar bear disturbance in open water, approximately 669.4 acres of habitat may be disturbed. The duration and frequency of in-water activity is temporary and intermittent during construction. Marine vessel traffic would increase, sealift barges would travel from southern Alaska, and smaller support vessels would originate from Oliktok Point. Vessels would have a transitory presence and a limited effect on marine mammals; marine mammals typically avoid vessels in known high-vessel areas. Further, sound levels of vessels are well below the injury thresholds for marine mammals. Bowhead and beluga whales harvested by Utqiaġvik (Barrow) and Nuiqsut in the fall and spring would not be disturbed by the increased vessel traffic between Atigaru Point and Oliktok Point because their migration corridor is generally in depths greater than 60 feet and all vessel traffic would occur in shallower water. Marine habitat would recover from noise almost immediately after construction and in-water work ceases. The MTI would not be polar bear denning habitat because the side slopes would not be steep enough (all slopes would be less than 8 degrees).

3.13.2.6.2 Option 2: Point Lonely Module Transfer Island

All of the effects to marine mammals described for Option 1 would apply to Option 2. The main difference is Option 2 would require double the total length (and acres) of ice roads (Table E.13.5 and E.13.6 in Appendix E.13), and 540,900 more ground traffic trips, and thus would have a higher intensity of disturbance or displacement than Option 1. Option 2 would also have 120 more fixed-wing aircraft flights (Table E.11.8 in Appendix E.11). Though Option 2 has more total miles and acres of ice infrastructure than Option 1, fewer of these acres would occur in terrestrial denning critical habitat (Figure 3.13.1); thus, intensity of habitat alteration from ice roads would be lesser than Option 1. The duration of construction would be the same for both options.

3.13.2.7 Oil Spills and Accidental Releases

The EIS evaluated potential effects from accidental spills. Chapter 4.0, *Spill Risk Analysis*, describes the likelihood, types, and sizes of spills that could occur. Under all action alternatives, spills and accidental releases of oil or other hazardous materials could occur. Spills associated with the storage, use, and transport of waste and hazardous materials during all Project phases would likely be contained to gravel or ice pads, inside structures, or within secondary containment structures. Therefore, these types of spills would not be expected to negatively affect marine mammals.

Spills from oil infrastructure could occur during drilling and operations from leaking wellheads, facility piping, process piping, or aboveground storage tanks but would likely be contained to, and cleaned up on, gravel pads or their immediate fringes. In the unlikely event that a pipeline spill occurs at a river crossing during high water flow, the extent of the accidental release could be larger and affect polar bear terrestrial habitat. A spill from a pipeline crossing of streams in the Willow area may reach the channels of Fish (Iqalliqpik) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the Fish (Iqalliqpik) Creek and Kalikpik River basin may preclude a spill into one of these rivers from reaching Harrison Bay.

If a reservoir blowout were to occur, there is the potential for oil to reach nearby freshwater lakes and stream channels; however, oil is unlikely to reach Harrison Bay due to the distance to the drill sites and the sinuous nature of the streams in the area (CPAI 2018a).

If a spill to the marine environment were to occur from vessels used during MTI construction or sealift module delivery, it would be expected to be very small to small, limited to refined products (e.g., diesel, lubricating oil), localized to the immediate area of the vessel route or MTI, and short in duration (less than 4 hours). The expected spill occurrence rates for these spill types would be low to very low and the spills would be expected to occur during construction of the module transport site itself or originate from smaller watercraft (e.g., tugs that handle the module transport barges, support vessels). It would be possible, although of very low likelihood, that a medium to very large spill could occur along existing marine waterways leading to the sealift module transfer site. This would only occur if a tug or barge transporting modules runs aground, sinks, or its containment compartment(s) were breached, and the contents released (USACE 2012). The duration of these spill types would vary from about a day to up to several days, depending on the spill's location and the proximity of the shore-based response. Similarly, the geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Since the duration and frequency of marine vessel use for the Project would be limited, the likelihood of a spill of this nature would be very low.

3.13.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. BMP F-1 stipulates minimum altitudes for aircraft flying near specified locations in NPR-A. Though the Willow area is not specified, all air traffic for the Project should maintain altitudes of 1,500 feet (except during takeoff and landing) to minimize effects to marine mammals.

In addition to existing NPR-A BMPs, and CPAI's design measures, the following mitigation could reduce impacts to marine mammals:

1. Avoid preferred habitats, where possible.

3.13.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with BMPs in place, some unavoidable impacts to marine mammals would occur including direct loss of habitat and disturbance and displacement due to noise and the physical presence of equipment or personnel. These impacts would be irretrievable throughout the life of the Project. Most impacts would not be irreversible or affect the long-term sustainability of marine mammals in the analysis area if reclamation of permanent infrastructure occurred. If reclamation of permanent infrastructure did not occur, effects would be irreversible. The alteration of nearshore habitat would be irreversible because even if the MTI is abandoned and reshaped, it would still exist.

3.14 Land Ownership and Use

The analysis area for land ownership and use extends from Oliktok Point on the east to Point Lonely on the west and 3 miles offshore into the Beaufort Sea to 2 miles south of the southernmost Project element (BT-5; Figure 3.14.1). The temporal scale for Project impacts would last beyond the construction and operation of the Project and would continue until reclamation is complete. Research on gravel pad restoration on the North Slope indicates that recovery of plant cover to comparable levels to adjacent tundra would be greater than 20 to 30 years (Everett 1980). If reclamation did not occur, effects would be permanent.

Because current and prospective future permitted recreation use in the analysis area is low (BLM 2012b), this land use is not analyzed in detail in this EIS.

3.14.1 Affected Environment

Land ownership in the analysis area differs by surface and subsurface estate, particularly for lands granted to Alaska Native Claims Settlement Act (ANCSA) corporations. ANCSA regional corporations (e.g., the ASRC typically received both surface and subsurface estates on lands transferred to them. Village corporations (e.g., Kuukpik) typically received surface estate, with subsurface estates granted to their regional corporation. Lands selected by ANCSA corporations but not conveyed (selected lands) remain federal lands managed by BLM.

Within the land use analysis area, approximately 50% of the surface estate (Figure 3.14.1) is managed by BLM. The Department of Defense has a land withdrawal at Oliktok Point occupying 591 acres. The State owns 580,514 acres (24.4%) of the study area east of the Colville River. The NSB has two parcels east of the Colville River, one near Kuparuk and one east of the main access road that heads south from Kuparuk DS2M; these make up 0.1% of the analysis area. Other non-federal surface ownership in the analysis area includes 145,160 (6.1%) acres conveyed to the Kuukpik (the ANCSA village corporation for Nuiqsut) and 31,819 acres (1.3%) have been selected by ANCSA corporations (selected lands) but not conveyed. There are several Native allotments in the western portion of the analysis area and others along the CRD and near Point Oliktok, making up 4,234 acres or 0.2% of the analysis area. Less than 0.1% of the land in the analysis area is private land. Surface land management in the analysis area is summarized in Table 3.14.1.

The state owns navigable waters subsurface onshore and tidal areas seaward of the Beaufort Sea coast out to 3 miles. The BLM manages subsurface rights on federally owned surface lands and on many, but not all Native allotments, including the subsurface in the BTU, where the subsurface aspects of the Project would occur (Figure 3.14.2).

The land within the analysis area is wildlife habitat and used for subsistence. Within the NPR-A, the BLM has authorized several research permits, **special recreation permits**, the NSB Community Winter Access Trail, and winter cross-country Right-of-Ways. Areas of industrial use (oil and gas exploration and development) occur in the Alpine and GMT developments. Nuiqsut is primarily residential, with some institutional and commercial uses.

Table 3.14.1. Surface Land Management in the Analysis Area

Land Manager	Acreage	Percent of Total
Bureau of Land Management	1,169,492	49.2
U.S. Department of Defense	591	0.0
Private	158	0.0
Alaska Native Allotment	4,234	0.2
Alaska Native Lands patented or interim conveyed[a]	145,160	6.1
Alaska Native Lands (selected)	31,819	1.3
State of Alaska	580,514	24.4
Local government	1,227	0.1
Undetermined (water bodies)	441,899	18.6
Total	**2,375,093**	**100.0**

[a] Also referred to as Alaska Native Claims Settlement Act lands.

The NSB regulates land use and development in the borough under the *North Slope Borough Area Wide Comprehensive Plan* (NSB 2005) and the NSB zoning regulations (North Slope Borough Municipal Code [NSBMC] Title 19). Three NSB zoning designations apply to areas within the analysis area:

- Resource Development Districts are designed to address resource impacts early and provide for streamlined permit approvals in each district.

- Conservation Districts are designed to conserve natural resources that residents depend on for subsistence.
- Village Districts govern city limits and coincide with the official boundaries of the City of Nuiqsut.

Conservation District is the default designation for lands outside of village districts that have not been rezoned for development. Conservation Districts allow for some exploration activities, but construction of oil and gas development facilities, such as gravel roads and pads, require lands to be rezoned to Resource Development District.

Rezoning to Resource Development District requires submittal of a detailed Master Development Plan (MDP) and documentation of conformance with other NSB conditions. While Resource Development District allows for more intensive resource development activities, permitted activities cannot permanently or seriously impair the surrounding ecosystem and its ability to support the plants and animals on which residents depend (NSBMC 2019). In the analysis area, lands owned by the Kuukpik that lie outside of city limits are zoned for Conservation, where not previously rezoned as part of the Alpine development (Figure 3.15.3).

The BLM manages the NPR-A under the plan adopted in the IAP/EIS ROD published in February 2013. This plan allows for oil and gas development in most areas of NPR-A, but restricts development within the TLSA, in river setbacks, and in and other key areas to balance development with resource protection and minimize adverse effects on key bird and caribou habitats. Specific stipulations and BMPs to be considered for the action alternatives are discussed in more detail in Appendix D, *Alternatives Development*.

3.14.2 Environmental Consequences

3.14.2.1 Applicable Existing Lease Stipulations and Best Management Practices

All existing NPR-A IAP LSs and BMPs affect land management as they are part of BLM's management plan for the NPR-A. Table 3.14.2 summarizes some of the existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate impacts to land ownership and land use from development activity (BLM 2013a). The LSs and BMPs would reduce impacts created by facilities, roads, airstrips, pipelines etc. on floodplains, rivers, streams, subsistence use, and hunting and fishing areas, and would provide opportunities for community involvement in planning to prevent conflicts with subsistence, cultural, and recreation uses.

Table 3.14.2. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Land Ownership and Use

LS or BMP	Description or Objective	Requirement
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing water bodies, water quality, and aquatic habitats.	Permanent facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.

LS or BMP	Description or Objective	Requirement
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult with affected communities per guidelines.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.
LS/BMP K-1	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).
LS/BMP K-2	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; and minimize the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect land use would include those to LS E-2 and BMPs E-5, E-7, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1) and freshwater intake pipelines at Lakes M0015 and R0064 (K-2). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also place new VSMs along existing pipeline corridors due to pipe rack capacity limits (deviation to BMP E-5); all alternatives would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip; and under Alternative C, the Willow processing facility would not be colocated with a drill site pad.

Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7), due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site pad or at narrow land corridors between lakes where it is not possible to maintain 500 feet separation between pipelines and roads without increasing potential impacts to waterbodies.

3.14.2.2 Action Alternatives and Module Delivery Options

The Willow MDP would serve as the MDP on which an application for rezoning would be based. The alternatives do not differ in the need for rezoning, but the number of acres rezoned may vary by alternative. Areas with existing infrastructure between Alpine and the GMT have been rezoned previously (Table 3.14.3). Most of the land affected under any alternative is managed by the BLM, with about one acre of ANCSA land. No private lands, NSB lands, or Native allotments would be affected. Approximately 13 acres of state-submerged lands would be affected by either module delivery option. All action alternatives would be consistent with the restrictions on land use in Resource Development District and would not permanently or seriously impair the surrounding ecosystem, as discussed in the Sections 3.9 through 3.13.

There would be no changes in land ownership under any of the action alternatives, and the changes in land use would be the same for all action alternatives. Land use would change from primarily subsistence harvest use and wildlife habitat with areas of oil exploration and development to specific areas of oil industry infrastructure, gravel drilling and operations pads, a processing facility, pipelines, and roads. Effects on subsistence and wildlife habitat land uses are discussed in Section 3.16, *Subsistence and Sociocultural Systems*, and Sections 3.10 through

3.14. The areas proposed for development under the action alternatives are all outside the Nuiqsut city boundaries and would not change land uses in the city.

The alternative would require BLM approval of deviations from specific LSs and BMPs related to setbacks, buffers, and special use areas within NPR-A. The BLM can approve these deviations if they achieve the objectives of the stipulation or BMP or if the effects of the deviation are evaluated within another EIS such as this document.

Alternative B's access road and pipeline cross through a mile of the Colville River Special Area raptor protection area and cross through a yellow-billed loon nest buffer. Infield roads and pipelines would also cross through the Judy (Iqalliqpik) Creek and Fish (Uvlutuuq) Creek river setbacks and additional yellow-billed loon nest buffers. This alternative also proposes an infield road, pipeline, and two drill sites (BT2 and BT4) within the TLSA (110 acres) and road, pipeline, and drill site (BT4) within the Teshekpuk Lake Caribou Habitat Area.

Alternative C would require most of the same deviations as Alternative B but would eliminate the road crossing through the Judy (Iqalliqpik) Creek river setback. This alternative would have an additional airstrip, storage, and camp facilities located near BT2 in the TLSA (178 acres).

Alternative D would require similar deviations to Alternatives B and C. This alternative would remove the mile of road through the Colville River Special Area raptor protection area. The infrastructure within the TLSA would cover 110 acres.

The sealift module delivery options would require ice roads from the module transfer islands to the operations center. The ice roads would cross through the Teshekpuk Lake Caribou Habitat Area. Option 1 (Proponent's MTI) would affect some river setback areas and a portion of the Teshekpuk Lake Caribou Habitat Area closed to leasing. Option 2 (Point Lonely MTI) crosses through similar river setback areas but much more of the Teshekpuk Lake Caribou Habitat Area, including areas closed to leasing and closed to leasing and non-subsistence infrastructure.

The alternatives and options differ in the acreages to be developed (Table 3.14.3). Alternative C would have the greatest footprint due to the elimination of a segment of infield road and the need for a second airstrip and operations center. Alternative D would have the smallest footprint through elimination of the access road. State offshore submerged lands would be temporarily occupied for module delivery options 1 and 2, which would use an offshore island. Given the vast scale of the analysis area, the difference in acreage among alternatives would not result in substantive differences in land use within the analysis area.

Table 3.14.3. Municipal Rezoning Needs and Total Project Footprint (acres) by Alternative or Option

Land Owner/Manager	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Road	Alternative D: Disconnected Access Road	Option 1: Proponent's Module Transfer Island	Option 2: Point Lonely Module Transfer Island
Bureau of Land Management	665.2	714.6	637.8	0.0	0.0
Department of Defense	0.0	0.0	0.0	0.0	0.0
Private	0.0	0.0	0.0	0.0	0.0
Alaska Native Allotment	0.0	0.0	0.0	0.0	0.0
Alaska Native Lands patented or interim conveyed	1.2	1.2	1.2	0.0	0.0
Alaska Native Lands (selected)	4.6	4.6	0.0	0.0	0.0
State of Alaska	0.0	0.0	0.0	12.8	13.0
Local government	0.0	0.0	0.0	0.0	0.0
Undetermined (water bodies)	1.1	0.8	1.1	0.0	0.0
Total footprint[a]	**672.1**	**717.4**	**640.3**	**12.8**	**13.0**
Acres of footprint zoned resource development	**4.5**	**3.5**	**1.2**	**0.0**	**0.0**

[a] Total Project footprint includes 229.6-acre mine site footprint.

3.14.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. No additional mitigation measures are suggested.

3.14.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with LSs, BMPs, and mitigation measures in place, shifts in land use are unavoidable and irretrievable during the life of the Project. However, these impacts are very small in context of the available lands in the area. These impacts would not be irreversible, nor would they impact long-term sustainability, if reclamation of permanent infrastructure occurs. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.15 Economics

The analysis area for economics is Nuiqsut (local economy), NSB (regional economy), and the State (state economy). Although Project activities are located on the North Slope in proximity to Nuiqsut, the employment generated by the Project and the revenues generated accrue to individuals and entities throughout the state. The temporal scale for the Project is defined as the beyond the life of the Project (30 years) until reclamation is complete (estimated to be greater than 20 to 30 years; Everett et al. 1985), as economic effects of operations would occur throughout this period. If reclamation did not occur, some effects could be permanent.

Information on the relevant economies are summarized below. This discussion tiers from Section 3.4.11, *Economy*, in the BLM Final IAP/EIS (2012b) and more detail on the regional and state economy is provided there.

3.15.1 Affected Environment

Key economic information for the three economies is summarized in Table 3.15.1.

Table 3.15.1. Summary of Key Economic Data (2012 through 2016 5-Year Estimates)

Economic Element	Nuiqsut	North Slope Borough	State of Alaska
Civilian labor force	162	5,990	384,093
Employed	130	5,393	353,954
Unemployed	32	597	30,139
Unemployment rate	19.8%	10.0%	7.8%
Mean/Median household income	$97,495/$84,464	$88,304/$72,027	$92,191/$74,444
Mean/Median family income	$88,604/$74,750	$94,337/$77,330	$103,495/$87,365
Per capita income	$24,312	$49,982	$34,191
Families below poverty level	2.4%	11.8%	7.0%
People below poverty level	6.4%	11.2%	10.1%

Source: U.S. Census 2018b

Note: The U.S. Census Bureau's American Community Survey report data collected between 2012 and 2014 calculates an average representative of that time period. This is the best national source for small area economic data.

3.15.1.1 Local Economy (Nuiqsut)

Nuiqsut is a small Iñupiat community incorporated as a second-class city under Alaska Statutes Title 29, Municipal Government. Second-class cities may provide local services and levy taxes; Nuiqsut has adopted a bed tax and a tobacco tax (ADCCED 2018a). Most economic activity in Nuiqsut is generated by the borough, city, and tribal governments, as well as the ANCSA corporations. Government jobs account for 63% of total employment and most employed residents work in public administration or educational and health services (U.S. Census 2018b). Construction, transportation, and utilities account for most other employment sectors and are often associated with government, ANCSA corporations, or the oil industry. Although the oil industry is the major private industry employer in the area, most oil industry jobs require specific skillsets and are filled by workers from outside the North Slope. The high unemployment rate (19.8%; Table 3.15.1) reflects the lack of employment opportunities for community residents.

The NSB conducts its own economic census survey periodically and provides estimates for the cities within the borough. The survey report from 2015 notes that the NSB considers unemployment in NSB communities to be underestimated by the U.S. Census and that 36.5% of the Nuiqsut labor force was unemployed (NSB 2016). The NSB also reports a much higher estimated proportion of Nuiqsut households fall below the poverty level (47%) compared to the 2.4% estimate by the U.S. Census (NSB 2016; U.S. Census 2018b). The NSB survey report cautions that some data, particularly on income, may be unreliable due to a high rate of missing data in some communities, including Nuiqsut.

Nuiqsut households receive approximately half of their income from wages and half from corporation and state permanent fund dividends (NSB 2016). Nuiqsut has lower per capita and household wage income than most other NSB communities but has higher dividend income than most. This is likely related to the proximity of recent oil and gas exploration and development on lands in the Nuiqsut vicinity. Kuukpik, the ANCSA village corporation for Nuiqsut, owns lands in the vicinity and provides oil field support services, including lodging services in Nuiqsut. Over 61% of household heads in Nuiqsut report receiving village corporation dividends, a decrease from 78% in 2010.

The cost of living in remote Alaskan communities like Nuiqsut are substantially higher (42%) than in Anchorage (Fried 2015; Fried and Robinson 2005). Nuiqsut has experienced some decrease in the cost of living since development of the Alpine oil field (approximately 4 miles north of the community). Alpine provides natural gas to Nuiqsut for heating, reducing a major household cost component.

The value of subsistence harvests is a substantial part of the local economy. Although not a cash resource, subsistence provides valuable food resources to community members; almost 99% of Nuiqsut households use subsistence food resources, and over 70% of households use subsistence resources for more than half of their diet (NSB 2016). Although subsistence resources are not traded in the cash economy, ADF&G estimates a replacement value of subsistence foods at $6 to $8 per pound (ADF&G 2016b). At that value, 2014 harvest levels would have had an estimated replacement value of $20,664 to $27,552 per household (ADF&G 2016b). Participation in subsistence also involved cash expenses for supplies, vehicles, and fuel used in harvests. Nuiqsut subsistence participants reported that they spent an average of $7,062 on subsistence activities in 2010 (NSB 2015c).

Nuiqsut is primarily a residential community, but it has institutional facilities associated with the city, borough, and tribe. Commercial businesses are limited, but Kuukpik operates a hotel in the city. The city's bed tax is 12% and generated $163,928 in revenue in 2017 (ADCCED 2018a). The city's tobacco tax (100 mills per cigarette) generated another $44,416. Most public infrastructure and services in the community (e.g., drinking water and wastewater, health, police, emergency services) are provided by the NSB (NSB 2015c).

Nuiqsut is eligible for grant funding under the NPR-A Impact Mitigation Fund Program. The BLM shares 50% of revenues generated by oil and gas development in the NPR-A with the state for essential public services and facilities, and the state must give priority to areas most directly or severely impacted by the NPR-A development. Nuiqsut received $6,492,596 in NPR-A mitigation grants over the past 10 years (ADCCED 2018b). These grants supported general government operations, youth center operations and maintenance, a boat ramp, and community center maintenance. The city also received another $289,636 in other state grants in the same period (ADCCED 2018b).

3.15.1.2 Regional Economy (North Slope Borough)

The NSB is a home rule borough under Title 29 and provides land use regulation, education, and other government services to residents across the North Slope. Home rule boroughs have broad discretion on providing services and have taxing authority[6]. The only tax levied by the NSB is property tax. The NSB economy is primarily based on oil and gas industry revenues; most NSB revenue is from property taxes on oil and gas infrastructure, such as processing equipment, pipelines, and other facilities. Property taxes provide more than $392 million (72%) of NSB's $542 million in total revenues, and oil and gas properties provide 95% of total property tax revenues (NSB 2017). North Slope oil production peaked in 1988 and then entered a steady decline through 2015 (USEIA 2016). Private investments made in response to state exploration and production incentives reversed the decline, and production increased in 2016 and 2017. NSB enterprise revenues for utility services at Prudhoe Bay decreased in 2017, but oil and gas property tax revenues increased (NSB 2017).

To manage the risks associated with a dependence on natural revenue extraction, the NSB has also invested revenues in an investment fund; this fund had investment earnings of $68.5 million and an asset value of $644.6 million in 2017 (NSB 2015a).

Twenty-six percent (26%) of employees in the NSB were classified as government employees, while 73% were classified as private sector employees for 2012 through 2016, with 27% of employees working in natural resources, primarily oil and gas (U.S. Census 2018b). However, this statistic is skewed as it includes nonresident oil and gas workers listing Prudhoe Bay as their primary place of residence as opposed to their employment location. The Alaska Department of Labor and Workforce Development (ADLWD) reported that in 2016, only about 18% of people working in the NSB were NSB residents (ADLWD 2016). In 2014, an estimated 18,786 non-NSB residents worked in the NSB (ADLWD 2017). These employees work extended schedules, primarily in oil industry–related jobs located at drill sites and processing facilities across the North Slope; they are housed in company facilities during their work shifts and regularly fly in and out of the NSB. About 40% of these workers

[6] Under Title 29, home-rule boroughs have authority to exercise any powers not specifically prohibited by state law. Home-rule boroughs adopt a charter that provides the services to be provided and service areas, as well as taxing authority for the borough.

came from outside Alaska in 2014 and 60% came from elsewhere in Alaska, mostly Anchorage and the Matanuska-Susitna Borough (ADLWD 2016).

The NSB reported that only 11 NSB residents (1% of employed residents) indicated that they worked in the oil and gas industry (NSB 2016). Many of the workers in other sectors, such as local government, construction, retail trade, professional and business, and education and health, are employed by subsidiary companies that provide a variety of services (e.g., hospitality, construction) to the oil and gas industry. Others are employed by the NSB or the State in jobs supported by oil and gas revenues. Total direct and indirect NSB-resident jobs supported by the oil and gas industry was estimated at 1,845 jobs and $105 million in income in 2016 (McDowell Group 2014). Based on this estimate of direct and indirect jobs associated with the oil and gas industry on the North Slope and the total number of employed persons, more than one in three jobs held by NSB residents was directly or indirectly supported by the oil and gas industry (McDowell Group 2014; U.S. Census 2017a).

The major contributors to household income for the NSB are wages (70%), corporation dividends (13%), the Alaska Permanent Fund dividend (9%), and income from other sources (8%) such as pensions, child support, and Social Security (NSB 2016). The U.S. Census Bureau (U.S. Census) reported that the 2012 to 2016 NSB median household income was $72,027, mean household income was $88,304, and per capita income was $49,982 and that 11.8% of NSB families had income below the poverty level (U.S. Census 2017b).[7] The NSB 2015 socioeconomic survey report provides very different income data: the NSB reported that 2015 average household income was $62,367, per capita income was $16,782, and 26% of all NSB households were below poverty level (NSB 2016).

The NSB provides public health and safety; water and wastewater; and transportation infrastructure primarily within village communities and in oil development areas. Most areas within the NSB are remote and uninhabited and have no public infrastructure or services.

The NSB also receives grant funding under the NPR-A Impact Mitigation Fund. The NSB received $29,748,182 in NPR-A impact mitigation grants over the past 10 years (ADCCED 2018b). NSB grants were used for a number of services, including school counselors, comprehensive planning for communities, and land management and permitting. The NSB received $20 million in other state grants over this same period (ADCCED 2018b).

3.15.1.3 Alaska's Economy

Alaska's economy is also tied closely to the oil and gas industry, with 72% of general fund revenues coming from oil and gas revenues in fiscal year 2016 (McDowell Group 2017). These revenues are generated by taxes on production, property, and corporate income, royalties, and other minor industry sources. The State supports local governments through a variety of grant programs. The majority of state funding over the past 10 years has been associated with the NPR-A impact mitigation grants discussed above. NPR-A impact mitigation grants accounted for 96% of all state grant funds to Nuiqsut over the past 10 years and 59% of total grant funds to the NSB (ADCCED 2018b). Other grants were associated with American Recovery and Reinvestment Act funding or specific legislative funding requests. These annual allocations from the State are a crucial source of revenue, especially to small, remote communities (Duke University Energy Initiative 2016).

State infrastructure and services on the North Slope are limited. The State owns and maintains an airport in Utqiaġvik and Deadhorse, but most other infrastructure and services on the North Slope are provided by the NSB.

Declining oil production and low oil prices in the last several years resulted in a declining oil revenues and industry activity in Alaska. Oil and gas revenues to the state have decreased from a high of $9.9 billion in fiscal year 2012 to $1.6 billion in fiscal year 2016 (McDowell Group 2017). Decreasing state revenues have resulted in budget deficits that have reduced state savings accounts and resulted in a decrease of 1,691 state jobs between March 2014 and March 2016 (Guettabi 2017). Private-sector jobs in Alaska also fell by 1,518 over that time period. The decline in oil production has been abated more recently, and several new oil fields are currently under exploration and/or development. However, state budget deficits are predicted to continue in the near future, with reduced funding of programs and projects likely leading to a smaller state economy for the near future.

3.15.2 Environmental Consequences

The North Slope communities have a mixed cash and subsistence economy. An assessment of the potential cash economy effects of the Willow MDP alternatives was prepared by Northern Economics Inc. (NEI) and is included as Appendix E.15, *Economics Technical Appendix*. The NEI economic assessment estimates the capital expenditures for the Project using proprietary project capital expenditure data from other developments with

[7] U.S. Census Bureau NSB data since 2015 includes 2,174 nonresidents housed at Prudhoe Bay, so these estimates may be high.

processing facilities on the North Slope and a regression model that considers the volume of oil and natural gas liquids produced over the life of the field.

The effects on the subsistence economy are described in detail in Section 3.16, *Subsistence and Sociocultural Systems*, and are not repeated in this section.

3.15.2.1 Applicable Existing Lease Stipulations and Best Management Practices

There are no existing NPR-A IAP LSs and BMPs that would apply to the Project to mitigate economic impacts.

3.15.2.2 Alternative A: No Action

Under Alternative A, the Project would not be developed and there would be no increase in employment or wages in Nuiqsut, the NSB, or the state. Employment opportunities in Nuiqsut and the NSB would remain at current levels, and oil sector employment in the state would likely decrease. New property tax revenues would not be generated for the NSB and no new oil and gas tax revenues would be added to the Alaska general fund or the NPR-A impact mitigation fund.

3.15.2.3 Alternative B: Proponent's Project

3.15.2.3.1 Construction and Drilling

Construction would result in increased employment locally, regionally, and state-wide. Direct construction employment from the Project would average anywhere from 225 to 800 jobs per year for the 5 to 7 years of full construction (varies by alternative) and average 25 to 35 jobs for the first and last year of construction. A small portion of these construction jobs are likely to be filled by NSB residents including some Nuiqsut residents. As with most oil field development employment, most of the jobs would be filled by non-residents of the NSB. Despite the low number of jobs filled by NSB residents, any industry employment would impact the local and regional economy given the limited non-government job opportunities. Local residents may also be employed by local industry support companies contracted to provide goods and services during construction. If local oil industry support companies, such as those owned by Kuukpik or ASRC, earn revenues on the Project, this would indirectly affect local incomes through increased dividends. Occupancy of the Kuukpik Hotel would likely increase during construction, increasing tax revenues from the city's 12% bed tax.

Construction effects on local services and infrastructure would be limited given the self-sufficient nature of North Slope oil field construction activities. Oil and gas development on the North Slope does not increase demand for local services, as construction camps are developed to provide lodging, food, utilities, and other services needed by workers.

Direct construction employment estimates are summarized in Table 3.15.2.

Table 3.15.2. Direct Construction Employment Estimates

Year	Seasonal Peak	Annual Average
2020	40	25
2021	375	225
2022	1600	800
2023	1200	775
2024	925	625
2025	550	250
2026	800	410
2027	500	235
2028	60	35
Average annual over the construction period	–	376

Source: CPAI

In addition to construction employment, drilling activities are estimated to generate 140 jobs per year. Construction and drilling employment would result in an additional 2,300 indirect and induced jobs (part- and full-time) per year. Oil industry wages average $147,584 per year and oil and gas extraction wages average $224,827 (ADLWD 2019). For 376 direct jobs, wages would average between $55.5 million and $84.5 million. Assuming an average salary of $57,000 for indirect and induced jobs throughout the Alaska economy, indirect and induced wages would total $131.1 million per year (NEI 2019).

While direct employment and wages generated by construction activities on the North Slope would account for only 1 to 2% of total employment in the state, indirect effects would accrue throughout the state as wages earned on the North Slope would be spent on goods and services in workers' home communities.

3.15.2.3.2 Operations

Once the operations phase begins, the Project would add an estimated 350 jobs through the life of the Project. Again, most jobs associated with the Project are likely to be filled by non-North Slope residents, but there would be an increase in opportunities for NSB and Nuiqsut residents as well, with the Project directly and with locally owned support service companies. Given the small employment base on the North Slope and the limited job opportunities, these few jobs can substantially affect the local and regional economy.

The 350 annual operations jobs would result in an additional 360 indirect and induced jobs per year. Wages associated with the direct operations jobs would range from $51.7 to $78.7 million per year. Indirect and induced wages would total $20.5 million per year.

Wages associated with drilling and operations employment would result in increased incomes locally, regionally, and statewide. NSB and Nuiqsut residents employed by the Project would increase their household wage income. Local industry support companies, such as those owned by Kuukpik and ASRC, would likely earn revenues from the Project; increasing corporation dividends that would contribute to local and regional household incomes.

Most employment and wages associated with drilling and operations are likely to go to Alaskans that do not live on the North Slope, and the increase in household incomes would be spread across the state. Although this would be a relatively small increase to the state economy, average wages in the oil industry are more than double the average wage across the state (Fried 2018), so the direct and indirect effects of these wages are still important on a statewide level.

The regional and state economies would gain revenues from Project development and the NSB would receive additional property tax revenues that would offset the declining value of older oil field property assets. The state would receive revenues from disbursement of federal royalties, property taxes, production taxes, and corporate income taxes. Table 3.15.3 summarizes revenues to the NSB, state, and federal government.

Table 3.15.3. Summary of State, Federal, and Borough Revenues from the Project (millions of 2019 U.S. Dollars)

Revenue Category	Alternative B	Alternative C	Alternative D
State of Alaska Royalty[a]	$2,529.3	$2,529.3	$$2,479.7
State of Alaska Tax[b]	$1,697.3	$1,697.3	$1,797.5
State of Alaska Oil Surcharge	$24.6	$24.6	$24.1
State of Alaska Total	**$4,251.2**	**$4,251.2**	**$4,301.1**
Federal Government Royalty	$2,529.3	$2,529.3	$2,479.7
Federal Government Corporate Income Tax	$1,889.5	$1,889.5	$1,872.0
Federal Government Gravel Sales	$9.9	$11.2	$10.7
Federal Government Total	**$4,428.7**	**$4,430.0**	**$4,362.4**
North Slope Borough Property Tax	$1,929.4	$1,929.4	$1,931.0

Source: NEI 2019

[a] State of Alaska Royalty – Royalties represent 50% disbursement of federal royalties related to the NPR-A Impact Mitigation Fund.

[b] State of Alaska taxes include property tax, production tax, and corporate income tax.

3.15.2.4 Alternative C: Disconnected Infield Roads

Employment and wage effects as well as tax and royalties from this alternative would be the same as described for Alternative B, except that Alternative C would have larger federal government gravel sales due to the larger gravel footprint required.

3.15.2.5 Alternative D: Disconnected Access

Economic effects of Alternative D would be similar to Alternatives B and C, but employment and wage effects would be somewhat lower. Overall, State and NSB revenues would be higher than Alternatives B and C, while Federal revenues would be lower. Differences in taxes and royalties reflect the slightly longer construction and operations duration, and slightly decreased production over the life of the Project (32 years versus 30 years for Alternatives B and C).

3.15.2.6 Module Delivery Options

Construction employment estimates provided for Alternative B assumed an MTI at Atigaru Point or Point Lonely. The module delivery option would not change drilling and operations employment. Neither of the module delivery options would result in any substantive change in the effects described above.

3.15.2.7 Oil Spills and Accidental Releases

Most oil spills and accidental releases would be on gravel pads and not require large or extensive responses. Response to oil spills or accidental releases could result in additional employment and wages in the NSB and for Nuiqsut residents if a large and extended response is required. Kuukpik could see increased revenues from providing support services for response activities. Employment regionally and within the state, as well as sales of goods and services, could increase over the response period.

3.15.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. There are no additional mitigation measures recommended for economic impacts.

3.15.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

There would not be unavoidable adverse, irretrievable, or irreversible impacts on economics. Similarly, the Project would not adversely impact the long-term economic sustainability of the area.

3.16 Subsistence and Sociocultural Systems

The analysis area for subsistence and sociocultural systems includes all areas used for subsistence activities by the communities of Nuiqsut and Utqiaġvik (Barrow), which have documented use near the Project and would be most likely to experience direct and indirect effects to subsistence uses. While the Project would not geographically overlap with subsistence use areas for other communities, indirect subsistence and sociocultural impacts of the Project could extend to other North Slope communities such as Atqasuk and Anaktuvuk Pass if the Project results in large-scale changes in the abundance or availability of subsistence resources such as caribou that are used by those communities. These effects, while unlikely to be apparent from the Willow Project alone, could be magnified when added to other past, present, and reasonably foreseeable future actions, and are therefore discussed in Section 3.19, *Cumulative Effects*.

In addition, this section analyzes a **direct effects analysis area**, which includes all subsistence use areas within 2.5 miles of Project infrastructure (uses are detailed in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*). The **alternatives analysis area** is the part of the direct effects analysis area around the onshore action alternatives (it excludes the module delivery options).

The analysis in this section summarizes and tiers off subsistence and sociocultural systems impact analyses in the Alpine Satellite Development Plan EIS(BLM 2004a, Section 3.4), GMT-1 EIS (BLM 2014a, Sections 3.4.2, 3.4.5, and 4.4.2), GMT-2 EIS (BLM 2018a, Sections 3.4.1, 3.4.3, 4.4.2, and 4.4.5), and the NPR-A IAP/EIS (BLM 2012b, Sections 3.4.3, 3.4.4, 4.4.13, and 4.4.14). The temporal scale for construction impacts is the duration of construction. The temporal scale for operational impacts is the life of the Project, or until reclamation is complete. Reclamation of onshore areas can take many years, depending on the tundra damage. If reclamation of onshore gravel fill did not occur, impacts from that fill would be permanent. In marine areas, after abandonment of the MTI, the island is expected to be reshaped by waves and ice and resemble a natural barrier island within 10 to 20 years (more details in 3.8.2.5.1, *Option 1:* Proponent's *Module Transfer Island,* in Section 3.8, *Water Resources*). Other impacts related to long-term changes in subsistence resource availability (e.g., changes in caribou distribution or migration) and subsistence harvesting patterns (e.g., reduced use of traditional harvesting areas) may extend beyond operation.

3.16.1 Affected Environment

3.16.1.1 Community Background and Demographics

The North Slope is a large but sparsely populated area which is inhabited primarily by Iñupiat living in eight small communities, the largest of which is Utqiaġvik, the seat of the NSB government (Figure 3.15.1). The communities of the North Slope share a cultural identity and have close social and kinship ties both within and between individual communities. The Iñupiat of the North Slope traditionally lived a semi-nomadic, subsistence-based lifestyle, using trade to acquire goods not readily available in their immediate area. Today, North Slope Iñupiat communities continue to actively engage in traditional subsistence activities, with substantial sharing of traditional foods across the region. Over 98% of all Iñupiat households reported using subsistence foods in a 2015 NSB survey, and a 2014 community snapshot report noted that subsistence foods made up between 50% and 70% of respondents' diets (NSB 2016). Sharing is a key Iñupiaq value which strengthens social ties and promotes the continuation and transmission of cultural values and traditions. Many subsistence traditions, such as the bowhead whale hunt, are centered on the sharing and distribution of subsistence foods across communities and regions (see Section 3.16.1.2).

Sociocultural systems among the Iñupiat of the North Slope underwent various changes following European and American contact. The primary forces of sociocultural change included the introduction of the whaling industry (and a cash economy) in the mid-nineteenth century; compulsory education which facilitated the centralization of people into permanent villages; introduction of modern technologies; conversion of many Iñupiat to Christianity; and oil and gas development. The establishment of the oil and gas industry on the North Slope in the 1970s substantially changed sociocultural systems in the region. The desire to develop oil and gas resources on the North Slope was a major factor in passage of the ANCSA and creation of ANCSA Native corporations, including regional corporations (e.g., Arctic Slope Regional Corporation [ASRC]) and village corporations (e.g., Kuukpik Corporation [Kuukpik]) in each community, as well as the creation of local municipalities. These corporations control money and land from the settlement agreement and were established with the intent to provide Alaska Natives with opportunities for self-control and self-determination. Alaska Natives were provided with shares in both a regional and a village corporation in 1971, and corporation dividends now make up a substantial portion of household income in the NSB. Shares in ANCSA corporations were originally only transferable by gift or inheritance, meaning some ANCSA corporation shareholders' descendants did not receive shares in the ANCSA corporations. In 1988, ANCSA was amended to allow ANCSA corporations to issue new shares to shareholders' descendants. ASRC has a program in place to issue a variety of share types to original shareholders' descendants. Some village corporations have also enrolled shareholders' descendants, while others, such as Kuukpik, have not. This has resulted in the percentage of Nuiqsut household heads reporting ownership of village corporation shares decreasing from 2010 to 2015; in Nuiqsut, 61% of household heads reported owning village corporation shares in 2015 compared to 78% of household heads in 2010 (NSB 2016).

ANCSA corporations and municipal governments (both borough and city) on the North Slope created new employment opportunities in communities and remain the primary employers in most communities. The NSB in particular was created to capture some of the financial opportunities of oil and gas development, and to use the revenues collected to provide facilities and services for residents of the North Slope. NSB services, including health care and education, provide employment opportunities throughout the borough. As the borough seat, Utqiaġvik has a stronger cash economy than most North Slope communities as well as a more diverse population (Table 3.16.1). Tribal governments continue to operate in and provide employment opportunities in each community.

The changes in sociocultural systems resulting from the growth of the cash economy on the North Slope occurred over a relatively short period of time and resulted in the establishment of a mixed subsistence-cash economy where families invest money from employment into small-scale, efficient technologies to harvest wild foods. The introduction of a cash economy, and differences in participation rates in the cash and subsistence economies between households, has resulted in increased stresses in some communities where some residents are impacted more from the cash economy than others. Factors affecting the distribution of economic impacts include opportunities for employment with government entities and the oil and gas industry, including support services, and ownership of shares in regional and village corporations. Community tensions associated with the increased cash economy and increased oil and gas industry development include a sense of unequal distribution of financial impacts, conflicting feelings over the cash economy versus the subsistence economy, and general concerns about industry development and its potential for adverse effects on the environment, subsistence resources and access, and human health. The NSB's 2015 economic profile and census report notes that respondents throughout NSB communities reported negative trends in access to subsistence resources, real household incomes, and food insecurity (NSB 2016).

Table 3.16.1. Analysis Area Demographic and Employment Data (2012–2016[a])

Community	Population[a]	Alaska Native (percent)[b]	Unemployment Rate (percent)
Anaktuvuk Pass	273	90.8	41.5
Atqasuk	167	96.4	9.7
Nuiqsut	347	89.3	19.8
Utqiaġvik (Barrow)	4,316	70.5	16.1
North Slope Borough	9,681	57.4	10.0

Source: U.S. Census 2018a, 2018b
[a] American Community Survey data is a 5-year estimate, not a point data source.
[b] Reported as the only race or in combination with one or more other races.

3.16.1.2 Definition of Subsistence

Subsistence is the cornerstone of the traditional relationship of the Iñupiat people with their environment. Residents of Nuiqsut and Utqiaġvik rely on subsistence harvests of plant and animal resources for nutrition and for their cultural, economic, and social well-being. Activities associated with subsistence—processing; sharing; redistribution networks; cooperative and individual hunting, fishing, and gathering; and ceremonial activities—strengthen community and family social ties, reinforce community and individual cultural identity, and provide a link between contemporary Alaska Natives and their ancestors. These activities are guided by traditional knowledge, based on a long-standing relationship with the environment.

Like other North Slope communities, Nuiqsut and Utqiaġvik residents participate in a mixed, subsistence-market economy (Walker and Wolfe 1987), where residents invest money to purchase equipment and supplies (e.g., boats, snow machines, gill nets, fuel) to support subsistence activities. Native corporation dividends (Section 3.15, *Economics*) rely heavily on oil and gas development, and many residents invest their dividends and employment income into their subsistence way of life. Sharing subsistence foods with other communities is a major component of the mixed economy and is facilitated by advancements in rural transportation and technology.

Subsistence activities on lands in Alaska, including private lands, are subject to state and/or federal regulations. The Project would be located primarily on federal lands within the NPR-A, although pipelines would cross lands owned by Kuukpik and the State.

3.16.1.3 Overview of Subsistence Uses

This section provides an overview of subsistence use areas, timing of subsistence activities, harvest data, and existing impact levels for Nuiqsut and Utqiaġvik. Appendix E.16 provides details related to Nuiqsut and Utqiaġvik subsistence uses, in addition to subsistence uses within the direct effects analysis area. See Sections 3.10 through 3.13 (*Fish, Birds, Terrestrial Mammals*, and *Marine Mammals*) for details regarding the relative abundance and distribution of subsistence resources.

3.16.1.3.1 Nuiqsut

Subsistence use areas for Nuiqsut are shown on Figures 3.16.1 through 3.16.3 (and Figures E.16.1 through E.16.9 in Appendix E.16). Contemporary Nuiqsut subsistence use areas (Figure 3.16.1) for all resources exist over a large area extending from Utqiaġvik in the west and Anaktuvuk Pass in the south to Kaktovik in the east and in areas offshore from the CRD and Cross Island. Areas of higher overlapping use occur around the Colville River, in overland areas to the west and south of Nuiqsut, and in the Beaufort Sea. Historical or lifetime use areas for Nuiqsut occur in an a somewhat smaller area than contemporary uses focused around the Colville River, west toward Teshekpuk Lake, east to Prudhoe Bay, and offshore up to 15 miles. More recent subsistence use area data extend much farther offshore, occur in a larger overland area (i.e., areas accessed by snow machine), and indicate a shifting away from the Prudhoe Bay development area. The expansion of offshore and overland use areas are likely due to a number of factors including changes in resource availability and better transportation technologies. In the case of the Prudhoe Bay area, avoidance of industrial development has been documented in a number of studies and has been cited as a primary reason for this shift. Other reported reasons for the reduced use of the Prudhoe Bay area include changes to hunting regulations in that area, security restrictions, and increased obstacles to overland travel due to the construction of pipelines and roads. The primary differences in historical (Figure 3.16.2) and contemporary (Figure 3.16.1) subsistence uses is a shifting away from the Prudhoe Bay development area in more recently documented use areas, and a greater expanse of overland use areas (i.e., those accessed by snow machine).

Use areas vary by resource; the larger overland areas shown on Figure 3.16.1 are those of subsistence activities conducted in the winter months by snow machine, such as hunting wolf, wolverine, caribou, and upland game birds, and conducted in a somewhat smaller area during the spring for goose. Summer and fall subsistence activities are generally focused along river systems, in offshore areas, and in smaller overland areas west of the Nuiqsut which are accessible by ATV. Caribou is a resource of specific interest in this EIS because of its importance to the community and the potential impacts on migration. Caribou subsistence use areas (Figure 3.16.3) show high use of the Colville River and areas west of the community toward Fish (Uvlutuuq) Creek for caribou hunting for the 2008 to 2016 period. Comparison of these use areas to those documented in the past (Figure E.16.2 in Appendix E.16) indicate less use of the middle CRD and Fish (Iqalliqpik) Creek and a smaller extent of overland use areas in recent years. Figures E.16.1 through E.16.9 (Appendix E.16) display additional resource-specific subsistence use areas for all available study years in Nuiqsut.

Nuiqsut subsistence activities occur year-round, with a peak in overall subsistence effort (number of resources harvested) in August and September (Table E.16.7 in Appendix E.16). Waterfowl hunting, which begins in April and peaks in May/June, signals the arrival of spring in Nuiqsut. Breakup occurs as early as May and is when residents' primary travel method shifts from snow machine to boat (Table E.16.8 in Appendix E.16). From May through September, residents travel along the Colville River and its tributaries, Fish (Uvlutuuq) Creek, and into the Beaufort Sea to harvest resources such as caribou, waterfowl, seals, fish, and vegetation. Moose hunting occurs in August and September upriver from the community and is often combined with caribou hunting. Bowhead whaling occurs in September from the community's whaling base at Cross Island; preparations for the whaling season begin in August. Harvesters spend October and November on the fall Arctic cisco fishery and harvest caribou in overland areas near the community. Recent years have seen an increase in the use of trucks to access subsistence harvesting areas along the road system (Table E.16.8 in Appendix E.16). During the winter or early spring months of November through April, furbearer hunters travel by snow machine to pursue wolves and wolverines, target caribou and ptarmigan as needed and available, and fish for burbot through the ice.

Available data on Nuiqsut harvest amounts and community participation rates are summarized in Table 3.16.2 and Appendix E.16. On average, Nuiqsut households harvest 679 pounds of subsistence resources per capita annually. In terms of edible pounds, the annual subsistence harvest is made up almost equally of marine mammals, large land mammals, and non-salmon fish, with waterfowl, salmon, and vegetation contributing lesser amounts (Table 3.16.2). The primary species harvested by Nuiqsut households are bowhead whale, caribou, and whitefish (including Arctic cisco and broad whitefish; Table E.16.3 in Appendix E.16). An average of 100% of households use subsistence resources during any given year and 95% attempt harvests of resources (Table 3.16.2). Species that involve the greatest amount of community participation (greater than 50% of households trying to harvest) include caribou, white-fronted goose, cloudberries, and several species of fish (Table E.16.9 in Appendix E.16). A high percentage of households also participate in sharing subsistence resources, with 93% giving and 98% receiving subsistence resources during available study years.

While subsistence harvests in Nuiqsut have remained relatively stable over time in terms of harvest amounts (ADF&G 2016a; SRB&A 2018a), the community has experienced various impacts related to oil and gas development and other activities in the region since resettlement in 1973. Impacts include disruption of subsistence activities from increased air and ground traffic; decreased access to traditional use areas resulting from security restrictions and increased infrastructure (e.g., pipelines, roads, and pads); reduced availability of subsistence resources due to disruption from oil and gas activity and infrastructure; avoidance of subsistence foods due to contamination concerns; and avoidance of traditional use areas due to discomfort about hunting around industrial development (SRB&A 2009, 2017b, 2018a). Throughout the 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, between 27% (in Year 9) and 72% (in Year 1) of harvesters reported one or more impacts during individual study years. While impacts related to helicopter traffic have decreased in recent years, impacts related to human-made structures have increased slightly, likely related to increased road infrastructure in the area (SRB&A 2018a). In addition, between 33% and 46% of harvesters reported they avoid developed areas during individual study years (CPAI 2018b).

Table 3.16.2. Selected Nuiqsut Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds per Capita	Total Harvest (%)	Households Using (%)	Households Attempting to Harvest (%)	Households Giving (%)	Households Receiving (%)
All resources	679	100	100	95	93	98
Salmon	5	<1	65	43	31	35
Non-salmon fish	209	30.6	97	81	81	79
Large land mammals	224	32.6	96	77	77	78
Small land mammals	<1	<1	45	41	16	12
Marine mammals	226	33.8	97	54	60	97
Migratory birds	13	2.3	85	78	58	52
Upland game birds	2	<1	54	48	36	15
Bird eggs	<1	<1	24	16	8	11
Vegetation	1	<1	61	52	19	33

Sources: 1985 (ADF&G 2018); 1992 (Fuller and George 1999); 1993 (Pedersen 1995); 1994–1995 (Brower and Hepa 1998); 1995–1996, 2000–2001 (Bacon, Hepa et al. 2009); 2014 (ADF&G 2016a)
Note: See Tables E.16.2 and E.16.3 in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*, for data by study year.

Approximately 24% of Nuiqsut subsistence use areas occur within the direct effects analysis area (Table E.16.1 in Appendix E.16). The primary resources harvested by residents within these areas include caribou, wolf, wolverine, goose, and seal (Table E.16.5 in Appendix E.16). A small number of respondents have reported use areas for eiders, broad whitefish, moose, and burbot within the direct effects area. Caribou, wolves, wolverine, and goose are the primary resources harvested by Nuiqsut throughout the direct effects analysis area, particularly around the Project area and module delivery option ice roads. In addition, seal and eider hunting occur offshore near the module delivery options. Residents of Nuiqsut commonly harvest fish (particularly broad whitefish) downstream from the Project in Fish (Uvlutuuq) Creek. Across 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, the direct effects analysis area held between 6% and 19% of reported caribou harvests (Table E.16.4 in Appendix E.16). While some studies have documented harvesting additional resources such as vegetation and moose within the direct effects area, these are not common uses of those areas. Use of the direct effects analysis area occurs year-round, peaking in winter for resources such as wolf and wolverine, spring for goose and eider, and summer for caribou, seal, and fish (Figure E.16.1 in Appendix E.16). Snow machines and ATVs are the primary methods of travel to the direct effects area, although residents also access the area—particularly the offshore and coastal portions—by boat (Figure E.16.2 in Appendix E.16). Of the resources harvested within the direct effects area, caribou, white-fronted goose, and bearded seal are considered resources of major importance in Nuiqsut based on an analysis of selected variables (Table E.16.9 in Appendix E.16).

3.16.1.3.2 Utqiaġvik

Subsistence use areas for Utqiaġvik are shown on Figures 3.16.4 and 3.16.5 (and Figures E.16.10 through E.16.20 in Appendix E.16). Utqiaġvik contemporary subsistence use areas extend from Point Lay in the west to the Kuparuk River in the east, south into the foothills of the Brooks Range, and up to 80 miles offshore (Figure 3.16.4). Areas of higher overlapping use for the 1997 through 2006 time period occur along the Chipp, Meade, and Ikpikpuk rivers; in coastal areas between Dease Inlet and Peard Bay; and up to 20 miles offshore. Although not shown on Figure 3.16.4, a recent global positioning system (GPS) mapping study (Harcharek 2015) shows Utqiaġvik harvesters using an area similar to that documented in 1997 through 2006, with GPS tracks extending west to Wainwright, inland into the Brooks Range as far south as Anaktuvuk Pass, east beyond the Colville River, and varying distances offshore. Historical and lifetime Utqiaġvik subsistence use areas show a somewhat smaller but still extensive area compared to the same time period (Figure 3.16.5).

Figures E.16.10 through E.16.20 in Appendix E.16 display additional resource-specific subsistence use areas for all available study years in Utqiaġvik. Furbearers, caribou, and waterfowl are harvested in large overland areas south, southwest, and southeast of the community. Certain activities such as harvesting fish and waterfowl are more focused around river drainages, as is caribou hunting during the open-water months. Caribou and furbearer hunting involve the greatest overland extent of travel from Utqiaġvik, while marine mammal hunting is generally limited to offshore use areas in the Chukchi and Beaufort seas.

Utqiaġvik subsistence activities also occur year-round but peak in the months of June, August, and September (Table E.16.15 in Appendix E.16). April represents the end of the winter furbearer hunting and trapping season and the beginning of the spring bowhead whale hunt, which also includes incidental eider harvests at whaling camps and overland goose hunting. Starting in June, residents continue to hunt goose by snow machine but also begin to travel by boat in offshore, coastal, and riverine areas to harvest marine mammals (seal and walrus), eiders, caribou, fish, and berries. In summer, residents set nets in lagoons, lakes, and rivers for various fish species, with an emphasis on broad whitefish. Bowhead whaling resumes in offshore waters during the months of September and October, and non-whaling crew members continue to hunt resources such as caribou and fish, with the under-ice fishery peaking in October. Some individuals may travel to the Colville River to hunt moose during the fall months. Residents shift to traveling by snow machine again in November through April and target furbearers with a secondary emphasis on resources such as caribou, upland birds, fish, and ringed seal.

Available data on Utqiaġvik harvest amounts and community participation rates are summarized in Table 3.16.3 and Appendix E.16. On average, Utqiaġvik households harvest 265 pounds of subsistence resources per capita annually. In terms of edible pounds, most of the annual subsistence harvest is made up marine mammals (63.8%), followed by large land mammals (25.5%), and non-salmon fish (6.6%), with other resources such as migratory birds and salmon contributing lesser amounts (Table 3.16.3).

Table 3.16.3. Selected Utqiaġvik Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds per Capita	Total Harvest (%)	Households Using (%)	Households Attempting to Harvest (%)	Households Giving (%)	Households Receiving (%)
All resources	265	100	89	57	63	87
Salmon	7	0.8	69	26	26	55
Non-salmon fish	28	6.6	69	29	37	60
Large land mammals	81	25.5	72	39	39	57
Small land mammals	<1	<0.1	8	6	2	4
Marine mammals	144	63.8	71	30	45	70
Migratory birds	8	2.9	53	35	29	35
Upland game birds	<1	0.1	9	9	4	1
Bird eggs	<1	0.1	13	7	3	7
Vegetation	1	0.1	43	17	15	35

Sources: 1987–1989 (SRB&A and ISER 1993); 1992 (Fuller and George 1999); 1995–1996, 1996–1997, 2000, 2001, 2003 (Bacon, Hepa et al. 2009); 2014 (ADF&G 2016a).
Note: See Tables E.16.11 through E.16.13 in Appendix E.16, *Subsistence and Sociocultural Systems Technical Appendix*, for data by study year.

Utqiaġvik households primarily harvest bowhead whale, followed by caribou. Species which have frequently contributed substantial amounts over the study years include seal (bearded and ringed), walrus, and broad whitefish (Table E.16.13 in Appendix E.16). An average of 89% of Utqiaġvik households use subsistence resources during any given year and 57% attempt harvests of resources (Table 3.16.3). These estimates include non-Native households and would likely be substantially higher for Native households alone. The highest rates of participation are for marine mammals, migratory birds, large land mammals, and non-salmon fish. A substantial percentage of households also share resources, with 63% giving and 87% receiving subsistence resources during available study years (Table 3.16.3).

A relatively small percentage of Utqiaġvik use areas (2%) occur within the 2.5-mile direct effects area (Table E.16.10 in Appendix E.16). The primary resources harvested by residents within these areas are wolf, wolverine, and caribou (26%, 26%, and 22% of harvesters, respectively), with a small number of harvesters also reporting use areas for seal and goose (Table E.16.14 in Appendix E.16). Caribou, wolf, and wolverine are harvested throughout the Project area, whereas seal is harvested near the module delivery options. Use of the direct effects area by Utqiaġvik harvesters peaks during the winter months of March through April, with a smaller peak in July and August (Figure E.16.3 in Appendix E.16). Travel is primarily by snow machine, with some coastal boat hunting as well (Figure E.16.3 in Appendix E.16). Of the resources harvested within the direct effects area, caribou and bearded seal are resources of major importance to Utqiaġvik, goose are of moderate importance, and wolf and wolverine are of minor importance (Table E.16.17 in Appendix E.16).

3.16.2 Environmental Consequences

Potential impacts to subsistence are discussed in terms of resource availability, resource abundance, and harvester access. Impacts related to harvester avoidance are addressed under the topic of harvester access; while harvester avoidance is not a physical or legal barrier to access, it is a documented harvester response resulting in a reduced availability of traditional use areas and resources for harvesters. The magnitude or intensity of impacts to subsistence uses vary depending on the relative material and cultural importance of the resource being affected; relative importance of resources is discussed in Section 3.16.1, *Affected Environment*, and Appendix E.16. Other impacts to sociocultural systems are more difficult to quantify or predict (e.g., impacts on cultural practices, values, and beliefs) or result from changes to resource abundance, resource availability, and harvester access (e.g., costs and time, competition). These potential impacts are addressed in Section 3.16.2.3.4, *Other Subsistence and Sociocultural Impacts*, where relevant in the discussion below, and in Section 3.19, *Cumulative Effects*.

3.16.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.16.4 summarizes existing LSs and BMPs that would apply to the Project and are intended to mitigate impacts to subsistence and sociocultural systems from development activity (BLM 2013a). The LS and BMPs would reduce impacts to subsistence resource availability and abundance, as well as subsistence use areas, and subsistence access associated with the construction, drilling, and operation of oil and gas facilities.

Table 3.16.4. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Subsistence and Sociocultural Systems

LS or BMP	Description or Objective	Requirement
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Protect the health and safety the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	If ambient air monitoring indicates that project-related emissions are causing or contributing to impacts that would cause unnecessary or undue degradation of the lands, cause exceedances of NAAQS, or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in activities to reduce these emissions.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	Implement a monitoring study of contaminants in locally-used subsistence foods. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment of the development. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee’s processes to reduce or eliminate emissions of the contaminant.
BMP A-12	Minimize negative health impacts associated with oil spills.	If an oil spill with potential impacts to public health occurs, consider long-term monitoring for contamination of subsistence food sources.

LS or BMP	Description or Objective	Requirement
BMP B-2	Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.	Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas less than 4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community.
BMP C-2	Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.	Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect tundra. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation.
BMP C-3	Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.	Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from the ordinary high-water mark of fish-bearing waterways.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Above ground pipelines shall be elevated a minimum of 7 feet. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required. A minimum distance of 500 feet between pipelines and roads shall be maintained.
BMP E-9	Avoidance of human-caused increases in populations of predators of ground-nesting birds.	Utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Feeding of wildlife is prohibited.
BMP E-10	Prevention of migrating waterfowl from striking oil and gas and related facilities during low light conditions.	Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.
BMP E-12	Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.	An ecological land classification map of the development area shall be developed before approval of facility construction.

LS or BMP	Description or Objective	Requirement
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1. Land user shall submit an aircraft use plan as part of an oil and gas development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Consultations with agencies will be required if unacceptable disturbance is identified by subsistence users. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum. Aircraft shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area should be minimized from May 20 through August 20. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as aircraft approach the aircraft is too close and must break away.
LS G-1	Ensure long-term reclamation of land to its previous condition and use.	Prior to final abandonment, land used for oil and gas infrastructure shall be reclaimed to ensure eventual restoration of ecosystem function.
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Lessee/permittee shall consult directly with affected communities using the specified guidelines, including, but not limited to: Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the NSB, and the NPR-A Subsistence Advisory Panel to discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year. Include information concerning avoidance of conflicts with subsistence users.
LS/BMP K-1	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; minimize the loss of spawning, rearing, or over-wintering fish habitat; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines are prohibited in stream beds and adjacent to rivers listed. Rivers in the Project area that are listed include Colville River (2-mile setback), Fish (Uvlutuuq) Creek (3-mile setback), Judy (Iqalliqpik) Creek (0.5-mile setback), and Ublutuoch (Tiŋmiaqsiuġvik) River (0.5-mile setback).

LS or BMP	Description or Objective	Requirement
LS/BMP K-2	Minimize the disruption of natural flow patterns and changes to water quality; minimize the disruption of natural functions resulting from the loss or change of vegetative and physical characteristics of deepwater lakes; minimize the loss of spawning, rearing, or overwintering fish habitat; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.	Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are generally prohibited on the lake or lakebed within 0.25 mile of the ordinary high-water mark of any deep lake (i.e., depth greater than 13 feet).
BMP K-4a	Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.	Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose feeding habitat along lakeshore margins. Within the Goose Molting Area, aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20. Other restrictions are specified.
BMP K-5	(Teshekpuk Lake Caribou Habitat Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.	Design, implement, and report a study of caribou movement. The study shall include a minimum of four years of current data on the Teshekpuk Caribou Herd movements. Within the Teshekpuk Lake Caribou Habitat Area, permittee shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. A number of ground and air traffic restrictions are specified, including but not limited to: Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter. The permittee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20,

LS or BMP	Description or Objective	Requirement
LS/BMP K-6	(Coastal Area) Protect coastal waters and their value as fish and wildlife habitat; protect summer and winter shoreline habitat; prevent loss or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.	Facilities prohibited in coastal waters designated. Consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the NSB, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.
BMP K-9	(Teshekpuk Lake Caribou Movement Corridor) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.	Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines. Prior to the permitting of permanent oil and gas infrastructure, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources.
BMP K-10	(Southern Caribou Calving Area) Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake.	Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or other infrastructure associated with offshore oil and gas exploration and production, will be allowed.
BMP L-1	Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the damage of vegetation; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.	BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in BMP C-2.
BMP M-1	Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.	Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.
BMP M-2	Prevent the introduction, or spread, of nonnative, invasive plant species in the NPR-A.	Certify that all equipment and vehicles are weed-free prior to transporting them into the NPR-A. Monitor annually for invasive species, and submit a plan detailing methods for cleaning, monitoring, and weed control.

Source: BLM 2013a.
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation); NAAQS (National Ambient Air Quality Standards); NSB (North Slope Borough); NPR-A (National Petroleum Reserve in Alaska)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect subsistence and sociocultural systems would include those to LS E-2 and BMPs E-5, E-7, K-1, and K-2. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMPs K-1 and K-2) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2 in Section 3.10, *Fish*). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. All action alternatives would also place new VSMs along existing pipeline corridors due to pipe rack capacity limits (deviation to BMP E-5); all alternatives would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip; and under Alternative C, the Willow processing facility would not be colocated with a drill site pad.

Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7), due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site pad or at narrow land corridors between lakes where it is not possible to maintain 500 feet separation between pipelines and roads without increasing potential impacts to waterbodies. Caribou may experience more delays or deflections while crossing roads and pipelines in these locations where the separation is less than 500 feet.

3.16.2.2 Alternative A: No Action

Under Alternative A, the Project would not be constructed. No additional impacts to subsistence and sociocultural systems would occur over existing levels. Nuiqsut would continue to experience impacts to subsistence and sociocultural systems resulting from existing oil and gas development, ongoing exploration, and other activities in the region. Impacts from development infrastructure, traffic, human activity and noise, socioeconomic changes, and increasing interaction with non-Native Alaska businesses, governments, and people would continue to occur.

3.16.2.3 Alternative B: Proponent's Project

Figures 3.16.6 through 3.16.13 show Nuiqsut and Utqiaġvik subsistence use areas by resource and the alternatives analysis area, which is defined as the area surrounding the action alternatives and mine site. Tables 3.16.5 and 3.16.6 show resource harvests and use within the alternatives analysis area. Because the data are identical across the action alternatives, they are shown in a single column. These data are based on an analysis of available information from subsistence mapping studies in Nuiqsut and Utqiaġvik and are useful for understanding the likelihood and magnitude of direct impacts on subsistence uses. In these mapping studies, a sample of active harvesters in each community identified harvest areas and/or harvesting locations by resource on a map.

Table 3.16.5. Number and Percent of Nuiqsut and Utqiaġvik Harvesters Using the Alternatives Analysis Area by Resource Category

Resource Category	Number (Percent) of Nuiqsut Harvester Respondents Reporting Use Areas in Alternatives Analysis Area	Number (Percent) of Utqiaġvik Harvester Respondents Reporting Use Areas in Alternatives Analysis Area
Caribou	27 (84%)	5 (7%)
Wolverine	21 (88%)	7 (23%)
Wolf	20 (87%)	7 (23%)
Goose	3 (24%)	0 (0%)
All resources	29 (88%)	8 (11%)

Source: SRB&A 2010a

Table 3.16.6. Number and Percent of Nuiqsut Caribou Harvesters and Harvests Using the Alternatives Analysis Area by Study Year

Study Year	Number (Percent) of Nuiqsut Caribou Harvester Respondent Reporting Use Areas in Alternatives Analysis Area	Percent of Reported Caribou Harvests Occurring in Alternatives Analysis Area
Year 1	22 (61%)	5%
Year 2	23 (43%)	6%
Year 3	31 (54%)	7%
Year 4	26 (45%)	19%
Year 5	25 (44%)	13%
Year 6	18 (32%)	6%
Year 7	31 (52%)	14%
Year 8	22 (38%)	6%
Year 9	18 (29%)	7%

Source: SRB&A 2018

3.16.2.3.1 Resource Abundance

Project activity and infrastructure (e.g., gravel and ice roads, drill sites, mine site) would result in the removal or disturbance of habitat for resources such as fish (e.g., broad whitefish, grayling), waterfowl, and caribou. The Project may also cause direct mortality to individual animals through vehicle and aircraft collisions and blasting. Habitat loss and disturbance could reduce calving and nesting rates and survival for caribou and waterfowl in the vicinity of Project infrastructure and activity but would not have population-level effects on subsistence resources harvested within or downstream from the Project area (Sections 3.10 through 3.12). Construction-related impacts would occur in a larger area during a more limited time period. Operational activities and permanent Project infrastructure would be limited to the Project area over the life of the Project. Increased air and ground traffic would occur in a larger area and extend outside the Project area.

3.16.2.3.2 Resource Availability

Construction and operations activities, equipment, and infrastructure have the potential to affect resource availability by displacing and diverting subsistence resources. Noise, traffic, and human activity could deflect subsistence resources from the direct effects analysis area or cause skittish behavior, making them more difficult to harvest. Disturbances may be localized and considered minimal from a biological perspective, but they can have larger impacts on subsistence harvesters who often travel to certain areas at specific times of the year. While the exact time and place of a resource's movement changes annually, harvesters are generally able to apply their knowledge of movement patterns and associated factors to successfully locate and harvest caribou. When resource behavior is less predictable, harvest success declines. Impacts to resource availability would occur year-round. Impacts would be higher during winter construction when ice roads are present and activities are at their peak. Use of the direct effects analysis area by Nuiqsut and Utqiaġvik harvesters is highest during the winter (Figures E.16.1 and E.16.3 in Appendix E.16), although a substantial amount of summer and fall activity occurs in the eastern portion of the analysis area where the mine site is located (SRB&A 2010b, 2018a). A majority of noise and traffic associated with the mine would occur in winter. As the presence of permanent infrastructure grows throughout the construction and operations phases, the sources of impacts may change. For example, air traffic impacts may decrease over the course of the construction phase while ground traffic impacts may increase. Most noise- and human-related impacts would occur in and around the Project area; however, impacts related to air traffic, ice road traffic, and new pipeline construction (in areas of current development to the east of the Project) would occur in larger areas and affect a larger percentage of harvests and harvesters than activities in the alternatives analysis area.

3.16.2.3.2.1 Caribou

Data on harvest amounts within the alternatives analysis area are only available for Nuiqsut caribou harvests (Table 3.16.5). Based on these data, the alternatives analysis area for Alternative B provides between 5% and 19% of annual caribou harvests. Caribou harvesting is more concentrated in the eastern portion of the alternatives analysis area (Figure 3.16.7 and 3.16.8). Caribou hunting activity has been more confined in recent years (2008–2017; Figure 3.16.8), but earlier studies show greater amounts of overland hunting near proposed Project infrastructure (Figure 3.16.7); during years with adequate snow cover, use of this area may be more common. Because current uses are more focused in the eastern portion of the alternatives analysis area, direct impacts to caribou resource availability are more likely to occur near the mine site (Figures 3.16.7 and 3.16.8). Indirect impacts on the availability of caribou are likely to occur if equipment and infrastructure west of key harvest areas block or divert caribou movement into residents' hunting areas west of the community. A larger percentage of Nuiqsut caribou harvests could be indirectly affected (east of the Project area) by construction and operations activities compared to being directly affected. Some residents may use existing and new roads to access hunting areas closer to the Project area, increasing the potential for direct impacts for those users. Utqiaġvik caribou hunting was reported throughout the alternative analysis area for the 1997–2006 time period but is characterized by low overlapping use (Figure 3.16.12).

Around the mine site, noise associated with gravel mining, including blasting, mining equipment and machinery, and excavation, could cause caribou to avoid the mine site area or to act skittishly. Blasting and excavation would occur over five construction seasons, primarily during the winter months when overall subsistence uses are at their peak in the area. The presence of the mine site and associated ice roads could deflect movement of caribou through the area, resulting in reduced availability closer to Nuiqsut; use of ice and gravel roads by Nuiqsut harvesters to access caribou farther from the community could help offset these impacts; however, all gravel haul ice roads would be off limits to subsistence users during construction and therefore could act as a barrier rather than facilitating access. In addition, residents may experience difficulty hunting along existing gravel roads or in overland areas during this time due to safety concerns about shooting in the direction of ice roads with high traffic volumes. The mine site would be allowed to fill with water following construction and may result in some changes to caribou distribution and movement within that area.

Air traffic, particularly helicopter traffic, has been the most commonly reported impact on caribou hunting (CPAI 2018b; SRB&A 2018a). Throughout the alternatives analysis area, air traffic could cause direct and indirect disturbances to caribou availability both within and outside of the Project footprint. During construction, fixed-wing airplanes would be the primary source of air traffic, with helicopters used to support ice road construction, surveying, and monitoring (CPAI 2018b). There would be increased fixed-wing traffic to Alpine for the first 2 years of construction, which could affect resource availability for residents hunting by boat in the CRD. Once the airstrip is constructed, air traffic to Project area would likely increase to multiple daily flights throughout the life of the Project, although at slightly lower levels during drilling and operations. Helicopter traffic would occur on a more periodic basis throughout the life of the Project. According to SRB&A (2018), the area west of Nuiqsut accounts for a substantial percentage of Nuiqsut's annual caribou harvest, and increased air traffic within that area could affect Nuiqsut harvesting success during the construction and operation phases. Impacts of air traffic to caribou resource availability would be most likely during the fall when caribou migrate in an easterly direction, often crossing through the Project area into areas heavily used by Nuiqsut caribou hunters (Figures 3.16.7 and 3.16.8; Figure E.16.2 in Appendix E.16).

In recent years, reports of ground traffic–related impacts have increased with the construction of gravel roads in the area (SRB&A 2016, 2017a, 2018a). Deflections or delays of caribou movement from roads and associated ground traffic and human activity have been documented both by active harvesters (SRB&A 2010a, 2011, 2012, 2013b, 2014, 2015, 2016, 2017a) and during behavioral studies on caribou, particularly for maternal caribou (displacement of between 1.24 and 2.5 miles [2 and 4 km] from roads) (Section 3.12, *Terrestrial Mammals*). Displacement of calving caribou would likely not have direct effects on hunter success, as hunting during the calving season is low. Effects on caribou movement are most likely to occur when linear structures are placed parallel to the herd's primary movement. Perpendicular roads may also intercept caribou and cause delayed crossing (BLM 2018a; CPAI 2018b). All Project roads would likely affect crossing patterns to some extent, and deflections and delays in migration could occur for up to several hours during periods of heavy traffic, resulting in reduced success for hunters traveling overland to the west of the community.

Deflected movements and delays become common where roads and pipelines are close to one another and where traffic rates exceed 15 vehicles per hour. (The effects of roads and pipelines on caribou are detailed in Section 3.12.) Traffic rates of over 15 vehicles per hour would be more common during construction. While traffic rates would be highest in winter, they could still exceed 15 trips per hour during summer when hunting activities are highest (Table E.12.7 in Appendix E.12*, Terrestrial Mammals Technical Appendix*). Therefore, decreased hunting success resulting from delayed caribou crossings could occur throughout the construction period. It is likely that caribou deflections would continue during drilling and operations but at a lower intensity and frequency than during construction. During operations, traffic rates are not expected to exceed 15 vehicles per hour. Temporary changes in distribution have not been shown to alter overall migration patterns or herd distribution (Section 3.12). However, small changes in caribou distribution and movement can have large impacts on hunter success.

According to CPAI (2018b), the Teshekpuk Caribou Herd may be less habituated to development activity than the Central Arctic Herd caribou, and thus more prone to disturbance. Impacts would most likely occur during the summer and fall months, when caribou hunting activity is highest (Table E.16.7 in Appendix E.16). During drilling and operations, caribou would continue to be deflected or delayed while crossing Project roads, although ground traffic would decrease somewhat during operations. During the oestrid fly season, groups of caribou could gather on pads and roads for insect relief; this may result in increased availability of caribou for individuals hunting along roads but may also increase the likelihood of vehicle strikes and mortalities. Individuals not using roads to access caribou may experience reduced success closer to Nuiqsut.

Use and storage of hazardous materials, treatment and disposal of wastewater, solid waste, and drilling waste, and generation of air emissions could also reduce caribou use if individuals perceive or confirm caribou to be contaminated and avoid harvesting caribou that feed near the Project and are harvested elsewhere. Both Nuiqsut and Utqiaġvik harvesters have reported avoiding harvests of subsistence resources in certain years due to concerns about contamination (SRB&A 2009); during a recent BOEM-funded study, 47% of Nuiqsut households reported avoidance in the previous year of certain subsistence foods due to concerns about contamination (SRB&A 2017b).

During operation, drilling noise may affect the availability of caribou. Studies show that caribou, especially females with calves, avoid drilling sites and caribou that do approach drilling sites spend less time feeding and lying down (NRC 2003). Thus, residents may experience reduced hunting success near Project drill sites.

In summary, the Project could both directly and indirectly affect the availability of caribou to Nuiqsut subsistence users. The alternatives analysis area has provided up to 19% of the total caribou harvest during some years, and harvests are even more concentrated directly east of the Project area. Thus, direct and indirect impacts on caribou availability within the area west of Nuiqsut could have substantial impacts to subsistence users.

3.16.2.3.2.2 Furbearers

Wolf and wolverine are the primary resources harvested by Nuiqsut and Utqiaġvik subsistence users in the Alternative B analysis area (in terms of the percentage of harvesters using the area). Relative to other resources, the availability of furbearers would be most impacted directly around Project activities and infrastructure due to their sensitivity to noise and human activity and tendency to avoid developed areas (SRB&A 2009). As shown on Figure 3.16.9, during the 1995–2006 time period, wolf and wolverine hunters reported high levels of overlapping use throughout a majority of the alternatives analysis area, including areas surrounding the road and the BT1, BT2, BT3, and BT5 drill sites. Drill site BT4 is in areas of low to moderate use for wolf and wolverine hunting. Low to moderate overlapping use for Utqiaġvik wolf and wolverine hunters also occurs in the alternative analysis area (Figure 3.16.13). During construction and operations, furbearers are likely to avoid areas with equipment and infrastructure, and increased levels of human activity, noise, and ground traffic. During the early construction phase, ground traffic would be highest during the winter months, when furbearer harvester numbers are at their highest. Increased air traffic west of Nuiqsut could also affect Nuiqsut and Utqiaġvik wolf and wolverine harvesters. Operations impacts would be similar to construction but would continue throughout the life of the Project at somewhat lower levels.

Noise associated with gravel mining could affect availability of furbearers by causing them to avoid the mine site or act skittishly. Furbearers may also avoid the mine site and associated ice roads due to the physical presence of construction equipment. Blasting and excavation would occur primarily during the winter months and have the greatest effect on wolf and wolverine hunting, which peaks during the winter months in the direct effects area (Figure E.16.1 in Appendix E.16).

3.16.2.3.2.3 Waterfowl

Nuiqsut waterfowl use areas overlap with the eastern portion of the alternative analysis area, in addition to a small portion where the analysis area intersects with goose hunting along Fish (Uvlutuuq and Iqalliqpik) Creek and Judy (Iqalliqpik) Creek (Figure 3.16.10). The removal of waterfowl habitat at the mine site (including nesting habitat) would reduce the availability of waterfowl in those areas during the construction phase, although residents generally report low overlapping use at the mine site itself. After mining is complete, the mine pit would fill with water, which may increase harvest opportunities through the creation of waterfowl habitat. (Though detailed reclamation plans would be coordinated with the agencies prior to construction, the pit would likely fill with water regardless of reclamation options.) Noise associated with gravel mining could also affect availability of waterfowl by causing them to avoid the mine site area or to act skittishly. Blasting and excavation would occur primarily during the winter months. Impacts on goose availability resulting from mining-related noise are unlikely due to the timing of goose hunting.

Placement of gravel for roads and pads would remove waterfowl habitat, and dust deposition from gravel roads would alter or reduce the quality of bird habitat. While the Project would remove a small fraction of total bird habitat in the area, bird displacement would occur, and residents may experience reduced success in formerly successful hunting areas.

Noise and ground and air traffic during construction and operation may also cause temporary disturbances to or displacement of waterfowl, causing temporary changes to harvester success; however, these disturbances would not likely affect overall resource availability for Nuiqsut harvesters. Operations impacts from noise and traffic would be similar to construction impacts. Impacts on waterfowl availability from ground traffic would occur at reduced levels during operation (less than half the traffic levels experienced during construction and drilling) but would continue throughout the life of the Project. In addition, ground traffic impacts would be most likely during construction when ice roads cross through areas of high overlapping use for goose hunters. Air traffic would continue at similar levels throughout the life of the Project. Operational drilling noise could displace waterfowl in the Project area (Section 3.11, *Birds*) but would not affect waterfowl availability for Nuiqsut harvesters as waterfowl are harvested at a substantial distance from the drill sites.

3.16.2.3.2.4 Fish

Ice road crossings over waterways such as Fish (Uvlutuuq) Creek could temporarily block passage of subsistence resources; however, such displacement would likely not cause changes in resource availability for harvesters downstream (Section 3.10).

Noise and disturbance related to in-water work (e.g., culvert installation) could temporarily displace fish upstream and downstream from construction activities; however, fish availability for Nuiqsut harvesters downstream from stream crossings (e.g., in Fish (Iqalliqpik) Creek) would likely not be affected. Fish are harvested at a substantial distance from the stream crossings.

Freshwater withdrawal could potentially affect fish availability in some freshwater lakes. In addition, dust deposition from truck traffic could alter lake habitat for sensitive fish species. Lake use for subsistence within the alternative analysis area is relatively limited.

Project use and storage of hazardous materials throughout the life of the Project could reduce the use of fish resources if fish or the streams they inhabit are perceived or confirmed to be contaminated, causing some individuals to avoid harvesting fish resources downstream from infrastructure and work areas.

3.16.2.3.3 Harvester Access

Tables 3.16.5 and 3.16.6 summarize the percent of harvesters using the alternatives analysis area. During an approximately 10-year period between 1995 and 2007, 88% of Nuiqsut harvesters and 11% of Utqiaġvik harvesters reported using the alternatives analysis areas (Table 3.16.5). For both communities, wolf and wolverine were the primary resource targeted, followed closely by caribou. Between 2008 and 2016, between 29% and 61% of Nuiqsut caribou harvesters used the alternatives analysis area on an annual basis; 84% used it over a 10-year period (Table 3.16.5). Thus, up to 84% of Nuiqsut caribou harvesters could be directly affected during one or more years of the Project, with smaller numbers on an annual basis. A 1,000-foot safety area around all Willow facilities would be in place and would prohibit discharge of firearms within those areas. In addition, according to CPAI's access guidelines, hunters would be asked to avoid shooting in the direction of people, work crews, equipment, pipelines, or infrastructure. Nuiqsut hunters already observe these guidelines at existing oil and gas facilities out of concern for human safety. The presence of infrastructure and human activity and associated safety considerations further reduces the area in which residents would be able to hunt. The distance at which residents can safely shoot around infrastructure varies depending on the firearm being used, but it could range from 0.5 mile for an AK 47 to 2.5 miles for a 30-06.

During construction and operations, residents would experience physical barriers to access from Project infrastructure, although tundra access ramps and road pullouts at regular distances (every 2.5 to 3 miles) along Project roads would help reduce those impacts. Harvesters traveling overland to access use areas for caribou, furbearers, and goose may be diverted around construction areas or operational infrastructure. For Nuiqsut and Utqiaġvik, the direct effects analysis area is primarily accessed by snow machine (Figures E.16.2 and E.16.4 in Appendix E.16), with Nuiqsut caribou hunting also occurring by four-wheeler (Figure E.16.2 in Appendix E.16) (SRB&A 2018a). Boats are also used in the direct effects area, but primarily in the marine area (Section 3.16.2.6, *Module Delivery Options*). Thus, physical barriers to access would occur for Nuiqsut and Utqiaġvik wolf, wolverine, and caribou harvesters, with Nuiqsut goose hunters also being affected. Nuiqsut harvesters access the eastern portion of the direct effects (and alternatives analysis) area during snow-free months using ATVs; these individuals, and individuals traveling by snow machine in the winter, may have to divert around the mine site area, which is located within areas of high overlapping use for caribou, wolf, wolverine (Figures E.16.2 and E.16.5 in Appendix E.16). Residents may also experience reduced access to certain construction areas if work areas are closed to access by local residents. After mining is complete, the mine pit would fill with water (regardless of if it were connected to adjacent streams during reclamation); reclamation plans would be coordinated with the agencies prior to construction. Caribou harvesters traveling to the west of the community by ATV during the summer and fall months may have to alter their usual routes due to the new waterbody; however, these impacts would be relatively minimal as harvesters generally do not use a single route when hunting overland.

Nuiqsut caribou hunters increasingly use trucks to access subsistence use areas north and west of the community (BLM 2018a; SRB&A 2018a). This corresponds with construction of the Nuiqsut Spur, Alpine CD5, and GMT-1 roads. Some hunters use gravel and ice roads to access hunting areas for caribou and furbearers west of Nuiqsut and goose hunting areas during the spring. Road use would most likely be from individuals who do not have access to other overland modes of transportation (e.g., snow machines, ATVs). During construction, gravel haul ice roads, including the ice road connecting the mine site to the existing road system, would be off limits to subsistence harvesters and would therefore pose as a barrier to subsistence access. In addition, residents may experience difficulty hunting along existing gravel roads or in overland areas during this time due to safety concerns about shooting in the direction of ice and other roads with high traffic volumes. Winter is generally a low time for caribou harvesting in Nuiqsut, so road use would be more likely for those who experienced reduced harvest success at other times of the year. Some Utqiaġvik harvesters may also access the Project road system in the winter via the NSB's Community Winter Access Trail (a snow trail). During operations, use of the Project area may increase for some individuals because of roads and tundra access ramps. The increased use of Project roads for subsistence harvesting may result in increased competition along the road. It may also create a new hunting corridor in the area, causing increased deflection of caribou during their fall migration toward the community's traditional hunting area to the west of Nuiqsut (SRB&A 2018a). This could result in reduced success for individuals who choose not to use Project roads and continue to hunt west of the community.

Nuiqsut harvesters use of newly built roads has been documented during the Nuiqsut Caribou Subsistence Monitoring Project (SRB&A 2018a). As shown in Table 3.16.7, just over half of households (54%) reported using the road system to hunt caribou in 2018. Use of roads lessened somewhat with distance from the community (e.g., 40% of households used the road between Alpine CD5 and GMT-1 versus 52% of households who used the Spur Road). In addition, the percentage of households using the road east of the Spur Road toward Alpine was substantially lower than other road sections. Thus, it is possible that road use in the Project area would be less common due to the distance from the community and the more concentrated nature of drill sites and roads.

Table 3.16.7. Nuiqsut Household Use of Roads for Caribou Hunting, by Road Area, 2018

Road Area	Percent of Households Using[a]
Any roads	54
Spur Road (Area 1)	52
East of Spur Road toward Alpine (Area 2)	10
West of Spur Road to CD5 (Area 3)	45
Between CD5 and GMT-1 (Area 4)	40

Note: CD5 (Colville Delta 5); GMT-1 (Greater Mooses Tooth 1)
[a] Total number of households was 70.

Of the households who used roads in 2018, 50% cited the ease of access to hunting areas, while around one-quarter mentioned the lack of access to non-road methods of transportation (i.e., did not have a boat or snow machine) (Table 3.16.8). A total of 18% of households reported using roads due to the availability of caribou along the road system. Of those households who did not use roads in 2018, 38% cited a preference for non-road modes of transportation (e.g., boats), while 25% indicated that they avoided roads due to industry. A total of 13% cited a general preference for other forms of (non-road) hunting. In summary, 46% of households reported not using roads, and a majority of those households indicated they did not use roads due to general avoidance of industry or personal hunting preferences.

Table 3.16.8. Reasons for Using or Not Using Roads for Caribou Hunting, 2018

Reason	Percent of Households Using Roads[a]	Percent of Households Not Using Roads[b]
Ease of use	50	–
Transportation method	26	38
Avoid industry	–	25
Resource availability	18	9
Personal preference	–	13
Security restrictions	–	3
Funds	3	–
No reason specified	16	16

[a] Total number of households using roads was 38.
[b] Total number of households not using roads was 32.

Use of Project roads and/or avoidance of previously used areas could cause an overall shift in hunting areas and may result in a loss of knowledge, particularly among the younger generation, of traditional hunting methods and use areas. This would continue throughout the life of the Project and, in some cases, could continue after the Project ends.

Some harvesters may avoid construction infrastructure due to discomfort hunting and shooting near industrial infrastructure; lack of knowledge about security protocols; concerns about resource contamination; and an assumed lack of resource availability near infrastructure. Harvesters would likely avoid the mine site area when traveling overland out of safety concerns. Between 51% and 61% of caribou harvesters reported avoidance of a subsistence use area during 4 years of the Nuiqsut Caribou Subsistence Monitoring Project, and between 33% and 46% did so due to development (CPAI 2018b; SRB&A 2018a). As noted above, nearly one-quarter of households cited avoidance of industry as a reason for not using roads in 2018 (Table 3.16.8). Thus, it is safe to assume that at least one-third of harvesters who use the alternatives analysis area (88% of all harvesters; Table 3.16.3) may experience avoidance during one or more years of construction.

Although the analysis areas in the Environmental Evaluation Document (EED) and this EIS are not identical, CPAI (2018b) notes that while a substantial percentage of Nuiqsut harvesters reported using the Willow area over a 10-year period for all resources, fewer used the area in the 12 months prior to their interview (18% for all resources). The percentage of harvesters using the alternatives analysis area (which includes the mine site) for caribou is higher, at between 29% and 61% annually, but lower than the percentage using the area over a 10-year period (84%). Thus, not all harvesters who have reported using the alternatives analysis area over a 10-year period would experience direct impacts on access during the construction phase or would actively avoid the area. Harvester avoidance generally occurs at a distance larger than development footprints (Pedersen, Wolfe et al. 2000; SRB&A 2009, 2017a). Thus, it is possible that avoidance would occur in an area larger than the alternatives analysis area. Impacts related to avoidance may be temporary (e.g., one hunting season) for some individuals; for other individuals, avoidance may occur throughout the duration of construction. For additional discussion of harvester avoidance and how it has affected Nuiqsut subsistence uses over time, see BLM 2014a and 2018a.

During operations, harvester avoidance of the Project area may be reduced from construction levels due to decreased noise and traffic disturbances, although avoidance responses would likely continue throughout the life of the Project for certain individuals. During the drilling and operations phase, most noise-related impacts would occur within the western portion of the alternatives analysis area as well as in other areas affected by Project-related air and ground traffic.

3.16.2.3.4 Other Subsistence and Sociocultural Impacts

Decreased harvester access or subsistence resource availability resulting from the Project (See Sections 3.16.2.3.2, *Resource Availability*, and 3.16.2.3.3, *Harvester Access*) would affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being. Harvesting, processing, consuming, and sharing subsistence resources allows cultural values and traditions to be taught to new generations; sharing in particular reinforces social bonds throughout the local community and the region while participation in subsistence activities allows for the transmission of knowledge about culturally important hunting and harvesting areas, Iñupiaq place names, harvest methods, and cultural values. Reduced participation or success in subsistence harvests adversely affects social health by weakening social bonds. Changes in resource availability can also result in harvesters having to spend greater amounts of time and effort, in addition to spending more on fuel and other supplies, to harvest subsistence resources. If residents travel farther to access subsistence resources due to changes in their migration and distribution, they may take greater risks to safety thus causing stress to themselves and others in the community. Decreases in harvests resulting from changes in resource availability would also reduce opportunities for engaging in subsistence activities, potentially increasing social problems associated with drugs and alcohol.

Impacts to sociocultural systems resulting from changes to subsistence resource availability and harvester access are most likely to occur for the community of Nuiqsut, as Nuiqsut harvesters most frequently use the potentially affected area and are most likely to experience direct and impacts. However, Utqiaġvik harvesters may also experience changes to sociocultural systems if the Project affects harvesting activities in the vicinity of Teshekpuk Lake or winter furbearer harvesting activities. Given the relationships between communities and the sharing of resources throughout the area, sociocultural effects could extend beyond Nuiqsut and Utqiaġvik. Though this is unlikely due to the Willow Project alone, when added to other past, present, and reasonably foreseeable future actions, the likelihood could increase, as discussed in Section 3.19, *Cumulative Effects*. Impacts on sociocultural systems from drilling and operations would be long term as these changes would affect current residents' use of and relationship to the area, and these changes would be transmitted to the next generation.

In addition to effects on sociocultural systems resulting from decreased resource availability or harvester access, residents may experience impacts to sociocultural systems resulting from increased interactions with non-local workers, changes in income and employment levels, and associated social tensions, During construction, the increase in personnel in Nuiqsut use areas could increase the risk of conflicts between workers and subsistence harvesters, particularly if residents and/or construction personnel are not properly informed of security restrictions and procedures. Implementation of cultural awareness training for all employees would help reduce the potential for such interactions.

Nuiqsut residents are also most likely to receive income from development, through wage employment or Kuukpik dividends. Project construction could result in increased employment opportunities and income for Nuiqsut residents. A majority of construction work would be seasonal or temporary (Section 3.15, *Economics*). Residents may invest the income from construction jobs and Kuukpik dividends into supplies and equipment (e.g., snow machines, fuel, ammunition) to support subsistence activities. Increased cash may help offset some adverse effects by allowing residents to invest in equipment that helps them access more subsistence harvest areas and increases subsistence harvest efficiency. A decrease in subsistence activity by certain households could have a larger impact on the community if these households are particularly active and distribute subsistence foods to less active households. Because most construction activity is in the winter, a generally lower time for subsistence activities (Table E.16.7 in Appendix E.16), subsistence/work conflicts would be fewer.

The availability of jobs for Nuiqsut residents would likely decrease during operations; however, income through increased Kuukpik dividends would continue throughout drilling and operations. A shifting of subsistence roles may occur in certain cases, where particularly active harvesters (e.g., super-harvester households) may no longer have time to provide subsistence foods and may rely on others to fill the subsistence roles they once held. The role of super-harvester households has been documented in a number of studies (Kofinas, BurnSilver et al. 2016; Wolfe 2004). Wolfe (2004) found that in most rural communities, approximately 30% of households (super-harvester households) harvest 70% of a community's total harvest. Kofinas et al. (2016) found that many super-harvester households are often also high-earning households. Subsistence roles within a community naturally change over time due to household circumstances (e.g., age and number of household members, employment levels) and communities generally adapt to these changes; however, a sudden change in employment levels in the community may cause at least a temporary disruption in social ties and roles within the community of Nuiqsut, which could cause a decline in the distribution of subsistence foods for a period of time. Larger disruptions to subsistence could come with high costs to social, cultural, and economic well-being, particularly to the more vulnerable low income, unconnected, and low-harvest households (Kofinas, BurnSilver et al. 2016).

3.16.2.4 Alternative C: Disconnected Infield Roads

Effects under Alternative C would be similar to those described for Alternative B, with the following differences:

Under Alternative C, the reduction in infield roads, including no road and bridge crossing Judy (Iqalliqpik) Creek and the removal of a perpendicular intersection of access and infield roads, would potentially reduce deflection of migrating caribou (Section 3.12), thus potentially reducing impacts to resource availability for Nuiqsut subsistence users. The lack of infield roads would increase the need for air traffic during the ice-free months, increasing potential disturbances to caribou and other resources, and Nuiqsut harvesters. Overall, fixed-wing and helicopter traffic would be slightly higher under Alternative C, while ground traffic would be slightly lower. The need for second airstrips and operations centers may result in air traffic disturbances occurring over a larger area.

Year-round road access for Nuiqsut residents would be less under Alternative C, as residents would not have road access to the areas west of Judy (Iqalliqpik) Creek during the snow-free months. The lack of year-round road access combined with increased air traffic may result in higher rates of harvester avoidance during certain times of the year. The decreased gravel road footprint under Alternative C, including the lack of a bridge crossing over Judy (Iqalliqpik) Creek, could reduce potential impacts to fish availability downstream from the Project (Section 3.10), particularly perceived contamination concerns for residents harvesting broad whitefish in Fish (Iqalliqpik) Creek, the receiving waters of Judy (Iqalliqpik) Creek. However, because the pipeline crossing would remain, the reduction in perceived contamination concerns under Alternative C would be minimal. Alternative C would include an additional year of mine pit operation that would extend impacts resulting from associated blasting/noise and ice roads.

3.16.2.5 Alternative D: Disconnected Access

Effects under Alternative D would be similar to those described for Alternative B, with the following differences:

Under Alternative D, the lack of a year-round road and associated ground traffic between GMT-2 and the Project area would reduce impacts to the fall caribou migration (Section 3.12). There would still be a pipeline between GMT-2 and the Project area. The lack of year-round road access would also increase the need for air traffic during the ice-free months, thus increasing potential air traffic disturbances to caribou and other resources, as well as Nuiqsut harvesters. The increase in air traffic under Alternative C would amount to, on average, approximately one additional fixed-wing trip per day during construction and drilling, although the increase in air traffic would likely be more concentrated in the ice-free months when many subsistence activities are at their peak. Overall, Alternative D would result in higher levels of both air and ground traffic; however, ground traffic would be reduced during the peak caribou hunting season.

Year-round road access for Nuiqsut residents would be less under Alternative D, as residents would not have access to areas beyond GMT-2 during the snow-free months. The lack of year-round access in combination with increased air traffic may result in higher rates of harvester avoidance during certain times of the year. The lack of year-round road between GMT-2 and the Project area under Alternative D may lessen the sense of being boxed in for Nuiqsut residents and reduce the amount of infrastructure within traditional use areas, thus having fewer impacts to sociocultural systems associated with loss of traditional use areas.

3.16.2.6 Module Delivery Options

3.16.2.6.1 Option 1: Proponent's Module Transfer Island

Figures 3.16.14 through 3.16.27 show Nuiqsut and Utqiaġvik subsistence use areas by resource. As shown in Tables 3.16.9 and 3.16.10, a majority of Nuiqsut harvesters (94%) reported using the MTI analysis area. Nuiqsut harvesters use the MTI analysis area primarily to harvest caribou, wolverine, wolf (with between 87% and 88% of harvesters using the area for each resource), and goose (55% of harvesters). These resources are harvested primarily in overland areas crossed by ice roads, particularly the ice road to the mine site (Figures 3.16.14 through 3.16.17). Nuiqsut areas of high overlapping use for caribou, wolf, and wolverine occur along the southern portion of MTI ice roads. The ice road to the mine site also crosses areas of high overlapping use for goose on Fish (Uvlutuuq) Creek (Figure 3.16.18). On an annual basis, the MTI analysis area provides between 4% and 11% of caribou harvests, primarily in areas surrounding the ice road crossing Fish (Iqalliqpik) Creek.

Nuiqsut harvesters use the offshore areas surrounding the MTI primarily for harvesting bearded seal (30% of harvesters), ringed seal (22%), and eider (11%) (Figures 3.16.19 and 3.16.20). Some coastal caribou hunting also occurs near the MTI, with Atigaru Point being an important traditional caribou hunting ground (SRB&A 2018a). Some broad whitefish harvesting occurs along Fish (Uvlutuuq) Creek in areas crossed by ice roads (Figure 3.16.21). A small percentage of harvesters report hunting moose in the MTI analysis area (Figure 3.16.22) where it crosses Fish (Iqalliqpik) Creek, but this is outside the core moose harvesting area for Nuiqsut (Figure E.16.3 in Appendix E.16).

Table 3.16.9. Number and Percentage of Nuiqsut and Utqiaġvik Harvesters, by Module Delivery Option Area, 1996–2007

Resource Category	Nuiqsut: Proponent's MTI	Nuiqsut: Point Lonely MTI	Utqiaġvik: Proponent's MTI	Utqiaġvik: Point Lonely MTI
Caribou	28 (88%)	28 (88%)	6 (8%)	16 (22%)
Wolverine	21 (88%)	21 (88%)	6 (19%)	7 (23%)
Wolf	20 (87%)	20 (87%)	6 (19%)	7 (23%)
Goose	18 (55%)	18 (55%)	–	1 (1%)
Eiders	3 (11%)	1 (4%)	–	–
Broad whitefish	3 (12%)	3 (12%)	–	–
Burbot	1 (3%)	1 (3%)	–	–
Moose	3 (10%)	3 (10%)	–	–
Bearded seal	8 (30%)	0 (0%)	1 (2%)	1 (2%)
Ringed seal	5 (22%)	0 (0%)	–	1 (2%)
All resources	31 (94%)	31 (94%)	9 (12%)	18 (24%)

Source: SRB&A 2010a
Note: MTI (module transfer island)

Utqiaġvik uses the MTI analysis area primarily for hunting wolf (19% of harvesters), wolverine (19%), and caribou (8%) (Table 3.16.7). These uses are generally in areas of low to moderate overlapping use surrounding the proposed ice roads (Figure 3.16.23 through 3.16.25). In addition, a small percentage (2%) of Utqiaġvik harvesters use the offshore areas near the MTI for hunting bearded seal while traveling along the coast (Figure 3.16.26).

Table 3.16.10. Number and Percentage of Nuiqsut Caribou Harvesters and Harvests, by Module Delivery Option Area, 2008–2016

Study Year	Total # of Active Harvester Respondents	Proponent's MTI Active Harvester Respondents	Point Lonely MTI Active Harvester Respondents	Proponent's MTI Caribou Harvests[a]	Point Lonely MTI Caribou Harvests[a]
Year 1	36	28 (78%)	26 (72%)	7%	6%
Year 2	53	24 (45%)	24 (45%)	6%	6%
Year 3	57	32 (56%)	32 (56%)	6%	6%
Year 4	58	30 (52%)	30 (52%)	15%	15%
Year 5	57	29 (51%)	25 (44%)	11%	10%
Year 6	57	19 (33%)	19 (33%)	7%	7%
Year 7	60	32 (53%)	32 (53%)	10%	10%
Year 8	58	23 (40%)	23 (40%)	4%	4%
Year 9	63	23 (35%)	21 (33%)	7%	7%

Source: SRB&A 2018
Note: MTI (module transfer island)
[a] Harvests are a percentage of the total reported harvests by interview respondents during each study year.

Construction and use of ice roads associated with the MTI could affect resource availability and harvester access. While construction activities associated with the MTI, including ice roads, would result in the temporary removal or disturbance of habitat for some resources and may also cause direct mortality to individual animals, these would not have population level effects on subsistence resources.

Noise and traffic associated with ice roads, and the physical presence of the ice roads themselves, could affect the availability of caribou, wolf, and wolverine for Nuiqsut and Utqiaġvik harvesters. The ice road may still be present in late April, when goose hunting along Fish (Uvlutuuq) Creek intensifies (Figure E.16.1 in Appendix E.16); thus, goose hunters could experience direct impacts on their hunting. Some hunters from Nuiqsut may use MTI ice roads, particularly the ice road crossing Fish (Iqalliqpik) Creek, to access hunting areas; however, use of roads lessens somewhat with distance from the community and so use of these ice roads may be limited. Others may avoid ice roads altogether. Because MTI ice roads would not be present during the fall caribou migration, it is unlikely they would cause overall changes in caribou distribution or migration; however, caribou may be deflected from ice roads in winter during times of heavy road traffic, affecting resource availability for caribou harvesters. During construction, peak ground traffic levels associated with the MTI would reach up to 8,900 trips daily, averaging 370 trips per hour in winter (Table E.11.10 in Appendix E.11, *Birds Technical Appendix*). Traffic volumes would reach or exceed 15 vehicles per hour, the rate at which caribou show increased disturbance, throughout construction and operation of the MTI. Some Nuiqsut and Utqiaġvik hunters traveling overland by snow machine may experience reduced access during the winter months if crossing through areas with ice roads. Snow machine hunters may also avoid ice roads due to noise and human activity or because of a perceived lack of resources in the area.

During construction of the MTI, noise generated from screeding, pile driving, and ice road and related vessel traffic could temporarily displace marine mammals and eiders, periodically resulting in reduced harvest success for Nuiqsut seal and eider hunters in the MTI area. MTI construction would occur during both the winter and summer (beginning in mid-July). Vessel traffic would occur during the ice-free open water season and could cause periodic displacement of seals and eiders for Nuiqsut hunters in Harrison Bay. Noise related to MTI construction would not cause overall impacts to resource availability (Section 3.13, *Marine Mammals*, and Section 3.11, *Birds*). Impacts to marine mammals would occur during construction (noise, human activity) and some habitat would be removed (Section 3.13). Some hunters may stay at a distance from the MTI and/or associated barges.

The presence of the MTI could affect the distribution of marine mammals and eiders within the immediate area (Sections 3.13 and 3.11); however, it is unlikely that this local displacement would have overall impacts on resource availability because the MTI is outside the primary seal and eider hunting area for Nuiqsut (Figures 3.16.19 and 3.16.20).

Seal and eider hunters may also temporarily avoid certain areas in Harrison Bay due to the presence of vessel traffic in areas of high overlapping use (Figure E.16.7 and E.16.9 in Appendix E.16). Although the area directly surrounding the MTI is not used as heavily by Nuiqsut harvesters, some individuals hunting along the coast or in offshore areas toward Atigaru Point may avoid the MTI during active construction activity. The presence of construction crews, particularly in the summer, would likely increase potential avoidance by Nuiqsut hunters.

A key concern voiced by stakeholders in regards to the Atigaru Point MTI is the potential for decreased access to coastal areas based on erosion and sedimentation around the island. Residents of the community of Nuiqsut have reported changes to the coastal area between the mouth of Fish (Iqalliqpik) Creek and Atigaru Point that have resulted in shallower waters and navigation issues. They are concerned that the MTI could contribute to the increasingly shallow waters in Harrison Bay, then it could further decrease access to coastal hunting areas as well as access into Fish (Iqalliqpik) Creek. Similar to other barrier islands in the Beaufort Sea, small amounts of shoaling may occur on the leeward side of the MTI; however, no additional accretion or further shallowing of the MTI area would be expected to occur (Section 3.8, *Water Resources*). Besides the MTI itself, no additional navigational hazard are expected for boaters. Whaling crews in Nuiqsut have reported navigational impacts on boat travel to Cross Island, which is perceived to be a result of erosion of manmade islands; crews have observed that the area between the coast and barrier islands has become shallower and more difficult to navigate (SRB&A 2018b). Small changes in coastal conditions can have more substantial impacts to boaters attempting to safely navigate ocean waters. While it is possible that the MTI may be used by some individuals as a stopover point when hunting in Harrison Bay by boat, future use of the island (once abandoned) is unclear. It is expected that the top of the MTI would drop below the water surface within 10 to 20 years and therefore would not be usable as a stopover point. If residents are no longer able to access the coastal areas near Atigaru Point, then they could experience reduced opportunities to teach younger generations about this traditionally important place, thus affecting sociocultural systems for Nuiqsut. As discussed in Section 3.16.2.3.4, *Other Subsistence and Sociocultural Impacts*, social organization, social cohesion, and transmission of cultural values would be adversely affected if changes in subsistence resource availability and harvester access and avoidance reduce subsistence participation, sharing of subsistence harvests, and passing on of subsistence traditions to younger generations.

3.16.2.6.2 Option 2: Point Lonely Module Transfer Island

Effects of Option 2 would be the same as described for Option 1, with the differences described below.

Option 2 is farther from Nuiqsut and outside the community's core seal and eider hunting areas and key traditional caribou hunting areas near Atigaru Point (Table 3.16.10; Figures 3.16.15 through 3.16.20). Thus, there would be limited impacts on offshore seal and eider and coastal caribou hunting for the community of Nuiqsut compared to Option 1. Ice roads associated with Point Lonely would affect a similar percentage of Nuiqsut wolf, wolverine, caribou, and goose harvesters. While ice roads would occur over a larger area, the additional acreage of ice roads under the Point Lonely option would occur in areas of low overlapping use for Nuiqsut. Compared to Atigaru Point, the Point Lonely MTI would require somewhat higher levels of ground and fixed-wing traffic.

Due to its closer proximity to the Teshekpuk Lake area, an important subsistence use area for some Utqiaġvik residents, Option 2 would affect a greater percentage of Utqiaġvik caribou (22%), wolf (23%), and wolverine (23%) harvesters (Table 3.16.9; Figures 3.16.24 and 3.16.25). The ice road would be to the east and northeast of moderate overlapping use areas for wolf and wolverine to the south of Teshekpuk Lake (Figure 3.16.25). A small percentage (2%) of Utqiaġvik harvesters hunt offshore from the Point Lonely area for bearded and ringed seal. A single, small, goose hunting area was documented for Utqiaġvik at the Option 2 site (Figure 3.16.27).

3.16.2.7 Oil Spills and Accidental Releases

An oil spill or blowout would likely affect the availability of fish, particularly broad whitefish, in Fish (Uvlutuuq) Creek, due to decreased resource abundance (Section 3.10) as well as harvester avoidance related to contamination concerns. Broad whitefish has accounted for between 5.3% and 45% of the total subsistence harvest during available study years (Table E.16.3 in Appendix E.16). A large oil spill or blowout could also affect the availability of birds within a larger area surrounding Fish (Iqalliqpik) Creek due to contamination concerns. Nearly 50% of Nuiqsut households reported avoiding subsistence foods they believed to be contaminated during the 2016 study year (SRB&A 2017b). Contamination concerns are generally more widespread for marine or riverine resources (e.g., broad whitefish) due to the greater potential for contaminants to spread outside of the immediate Project area; however, harvesters may also avoid harvesting caribou and waterfowl that feed in the vicinity of a spill. A large oil spill, although unlikely, could have substantial impacts on Nuiqsut subsistence uses for an extended period resulting in decreased subsistence harvests and associated sociocultural impacts. Residents may avoid a large area surrounding and downstream from the spill, which could result in a loss of traditional use areas over time and impacts to sociocultural systems resulting from decreased opportunities to share subsistence resources, participate in subsistence harvesting activities, and pass on subsistence traditions to the younger generation.

3.16.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. In addition, the BLM and the Proponent would strive to develop additional Project-specific BMPs to reduce impacts to subsistence and sociocultural systems.

3.16.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Even with BMPs in place, the subsistence impacts described above would be unavoidable and irretrievable during the life of the Project. Previous analyses have shown that many impacts to subsistence persist despite the implementation of BMPs (SRB&A 2013a, 2018a). Most impacts would not be irreversible if reclamation of permanent infrastructure occurred. However, impacts related to decreased knowledge of and cultural ties to developed areas may be irreversible. The creation of the MTI would be irreversible because even if the MTI is abandoned and reshaped, it would still exist. Multi-generational shifts in subsistence participation may be irreversible depending on local community response to the development. If reclamation of permanent infrastructure did not occur, effects would be irreversible.

3.17 Environmental Justice

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to take appropriate and necessary steps to identify and address disproportionately high and adverse effects of federal decisions on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.

This environmental justice analysis evaluates effects on the minority population in Nuiqsut, the community closest to the Project and most likely to be directly affected by social or environmental changes associated with Project development. Income and poverty data on Nuiqsut are inconsistent between data sources (U.S. Census versus NSB data) that provide measures of income and poverty. As noted in Section 3.15, *Economics*, U.S. Census data on mean and median household income and poverty rates show Nuiqsut has higher incomes and lower poverty rates than the NSB and the state as a whole. Median family and household incomes for Nuiqsut are substantially higher than the U.S. Department of Housing and Urban Development Low Income Limits and the Department of Health and Human Services poverty guidelines (HHS 2019; HUD 2019).

3.17.1 Affected Environment

Nuiqsut residents are considered a minority population as the community is 89% Alaska Native. Nuiqsut's median family income is $74,750 and mean family income is $88,604; these income levels exceed federal poverty and low-income guidelines (HHS 2019; HUD 2019; U.S. Census 2018b). As described in Section 3.15, the cost of living in remote Alaskan communities like Nuiqsut are substantially higher (42%) than in Anchorage (Fried 2015; Fried and Robinson 2005).

3.17.2 Meaningful Engagement

USEPA's 2016 environmental justice guidance stresses the importance of providing minority or low-income populations with meaningful engagement in environmental review processes (EPA 2016). Coordination with and involvement of Nuiqsut residents has occurred through four primary avenues of communication:

- During the initial phase of the Project, the BLM invited the Native Village of Nuiqsut and the City of Nuiqsut to participate in the environmental review process as cooperating agencies representing expertise in sociocultural, wildlife, and subsistence resources. The Native Village of Nuiqsut was also invited to participate in government-to-government consultation. The Native Village of Nuiqsut and the City of Nuiqsut have participated in cooperating agency meetings, including those pertaining to alternatives development and identification of key issues. They have also been offered opportunities to comment on draft resource analyses and sections of the EIS.
- In addition to agency meetings, BLM consults with the Native Village of Nuiqsut regularly through government-to-government discussion.
- BLM has invited the Native Village of Nuiqsut to participate in regularly scheduled meetings for the NPR-A Working Group (reinstituted in Spring of 2019).
- BLM also engaged Nuiqsut residents through public meetings in Nuiqsut to solicit input regarding the EIS process and concerns of the community, both through public scoping meetings and from community open house meetings regarding the Project. Iñupiaq translators were present during meetings in Nuiqsut. Public scoping was conducted from August 7, 2018, to September 20, 2018, to solicit input from the public and to inform the EIS. BLM provided the community of Nuiqsut an additional eight days (52 total days) to comment because many community members were participating in subsistence activities during much of the scoping period. More information on public scoping and comments received are provided Appendix B, *Public Engagement and Scoping Summary Report*.

Through the BLM's efforts to involve Nuiqsut residents, community members have provided input and expressed environmental justice concerns related to the potential Project impacts (adverse and positive) on human health, subsistence, Nuiqsut socioeconomics, caribou, general wildlife, and pollutants to air quality and water quality. Key points made by comment type are summarized in Table 3.17.1.

Table 3.17.1. Key Points Made by Nuiqsut Residents (Minority Population) in Scoping Comments

Comment Category	Summary of Comments
Subsistence	Evaluate positive effects of new roads for subsistence hunting and for people without off-road capable vehicles or snowmobiles. Evaluate adverse effects of air and ground traffic, blasting and mining activities, and project infrastructure on caribou migration patterns and other species of wildlife, and the resulting impacts to subsistence hunting, fishing, or whaling, especially for the Nuiqsut community. Provide mitigation for adverse impacts to Nuiqsut subsistence hunting. Evaluate both adverse and positive impacts of the access road on caribou, air and water quality, and increased subsistence access. Do not allow the gravel mine to be reclaimed and used as a human-made lake with artificially introduced fish for subsistence use. Give attention to important subsistence areas such as Fish Creek, Judy Creek, and Harrison Bay.

Comment Category	Summary of Comments
Nuiqsut Socioeconomics	Evaluate potential adverse socioeconomic or environmental justice impacts to the village of Nuiqsut resulting from: health impacts and cost of medical treatment, subsistence impacts and cost of food subsidies, and increased use of public resources including health clinics and emergency response resources, as well as evaluating whether Project-created jobs could specifically positively affect Nuiqsut. Some comments stated that the BLM should re-evaluate NPR-A royalty distributions, and whether royalties are being distributed in a fair and equitable manner where the number of royalty shares are commensurate with the severity of impacts felt by the community. The Native Village of Nuiqsut requests that any analysis of potential impacts to tribal communities and resources be performed in accordance with their Project and Land Management Evaluation Rubric as well as Section VIII of the Alaska National Interest Lands Conservation Act.
Caribou and General Wildlife	Evaluate impacts to caribou and wildlife migration patterns, flora, fauna, fish, aquatic and wildlife habitats, and fragmentation on wildlife. Identify existing protections for flora and fauna in the IAP including special areas protected under the IAP and set aside for their importance to caribou (Teshekpuk Lake and Colville River Special Areas); tundra habitats and species from thermokarst development; caribou migration patterns or avoidance effects from module delivery, aboveground or elevated pipelines, ice roads, winter activities; shorebirds and waterfowl from habitat loss and aircraft flushing; bird species of concern from habitat loss and roads; whales, seals, and other aquatic species from the gravel island in Harrison Bay; and fish species from road crossings and gravel mining. Evaluate impacts of gravel island and vessel traffic on nearshore and aquatic habitats, fish passage, whales and marine mammal movement, polar bear movement, and bird migration. Evaluate an alternative that minimizes impacts to caribou.
Human Health	Evaluate impacts on human health due to air and water pollution, stress, limited access to medical resources, or changes in traditional way of life and diet. Evaluate health concerns: respiratory and cardiovascular diseases, cancer, genetic mutations and endocrine disruption, bioaccumulation of toxins in animals and food, general exposure to toxins in air and drinking water, and reduced access to traditional food sources or inadequate food supply. Consider partnering with local, state, Tribal, and federal health officials to determine if an HIA is required. If needed, use a qualified third party to prepare the HIA.
Air Quality	Sources and impacts from Project emissions (fine particulate matter, diesel exhaust, anthrax released from thawing permafrost, benzene, hydrogen sulfide, ozone, smoke, and volatile organic compounds). Perform air quality modeling to support the analysis and identify potential mitigation and control measures.
Water Quality	Identify existing aquatic habitats and water resources in the area and evaluate water quality impacts including new water pollutants, compliance with water quality standards, downstream impacts, water use during construction or operation, groundwater injections, erosion and sedimentation, wastewater discharges, mercury and anthrax released from thawing permafrost, and xylene and benzene.
Teshekpuk Lake Special Area	Evaluate impacts to wetlands, caribou, other wildlife species and habitats within the Teshekpuk Lake Special Area, and resulting subsistence impacts to North Slope communities. Describe protections for the Teshekpuk Lake Special Area and how the project complies with applicable use or development restrictions.

Note: BLM (Bureau of Land Management); HIA (health impact assessment); IAP (Integrated Activity Plan); NPR-A (National Petroleum Reserve in Alaska)

3.17.3 Environmental Consequences

3.17.3.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.17.2 summarizes existing NPR-A IAP LSs and BMPs that would apply to the Project and are intended to mitigate environmental justice impacts from development activity (BLM 2013a). The LSs and BMPs would help reduce disproportionately high and adverse impacts on the minority population in Nuiqsut, the community closest to the Project that is most likely to be directly affected by social or environmental changes associated with Project development.

Table 3.17.2. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Environmental Justice

LS or BMP	Description or Objective	Requirement
BMP A-1	Protect the health and safety of the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations.	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.
BMP A-3	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment from disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use “ultra-low sulfur” diesel.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring, emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	Design and implement a monitoring study of contaminants in locally used subsistence foods.
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult with affected communities per guidelines.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee’s/permittee’s employees, agents, and contractors are prohibited when persons are on “work status.”
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

3.17.3.2 Alternative A: No Action

Under Alternative A, the Project would not be constructed. There would be no environmental justice effects from the No Action Alternative.

3.17.3.3 Alternative B: Proponent’s Project

3.17.3.3.1 Subsistence and Sociocultural Systems

The most substantial Project effects are related to subsistence harvest impacts. Subsistence harvests are part of the social, cultural, and economic fabric of Nuiqsut. Adverse effects to subsistence harvests affect social standing in the community, transmission of cultural traditions between generations, and food security for individual households and the community as a whole. Due to the integral role of subsistence, the environmental justice analysis focuses on it.

Project impacts on subsistence are discussed in Section 3.16, *Subsistence and Sociocultural Systems*. These effects would predominately be experienced by Nuiqsut residents as they are the primary subsistence users of the affected areas.

Resource availability could decrease due to loss or alteration of habitat for birds, fish, caribou and other terrestrial mammals, disturbance or displacement of animals, or direct injury or mortality. However, the decrease would not have population-level effects on subsistence resources harvested within or downstream from the Project area. Caribou and bird availability may be reduced in harvest areas near the Project and furbearer availability may decline near the gravel mine site, while overall fish and waterfowl availability in high-use harvest areas would not be affected.

Harvester access would be adversely affected by construction of roads through areas used for harvesting wolf, wolverine, caribou, and goose. As noted in Section 3.16, at least one-third of harvesters that use the Project area are likely to avoid the affected area during at least one year during construction. During operations, harvester access would be adversely affected by roads through areas used for harvesting. Some Nuiqsut caribou hunters use trucks to access subsistence harvest areas and may use roads constructed under this alternative. This could increase competition along the road and deflect caribou from the community's traditional harvest area, reducing success for those continuing to use traditional areas. Some subsistence harvesters also avoid developed areas due to concerns about security protocols and an assumed lack of resources around these areas.

Decreased harvester access or subsistence resource availability resulting from the Project would adversely affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being. Decreases in harvester access or subsistence resource availability would reduce opportunities for engaging in subsistence activities, potentially increasing social problems associated with drugs and alcohol. The poorest residents would bear disproportionate effects.

The effects on subsistence and sociocultural systems may be highly adverse and disproportionately borne by the Nuiqsut population.

3.17.3.3.2 Economics

Nuiqsut residents are also most likely to receive income from development, through employment wages or Kuukpik dividends. Though oil and gas development on the North Slope does not increase demand for local services, as construction camps are developed to provide lodging, food, utilities, and other services needed by workers, occupancy of the Kuukpik Hotel would likely increase during construction, increasing tax revenues from the city's 12% bed tax. The effects on Nuiqsut economics would not be highly adverse.

3.17.3.3.3 Public Health

The Project would result in additional employment opportunities in Nuiqsut. Although most construction jobs would be filled by non-locals, even a small number of additional jobs would positively impact the community's relatively small labor force. Project construction would increase household incomes for Nuiqsut residents employed with Project, and dividend income would also increase for ASRC and Kuukpik shareholders if these corporations have subsidiaries working on the Project.

Not all Nuiqsut residents would find jobs or receive ANCSA dividends, resulting in the potential for social tensions regarding an uneven distribution of money in the community. The Project would increase air and noise emissions and human activity in Nuiqsut's subsistence use area. This could increase stress in some Nuiqsut residents and lead to or exacerbate mental health issues such as anxiety and depression. Reduced subsistence harvester access or subsistence resource availability would adversely affect community health by reducing the availability of subsistence foods and increasing dependence on store-bought foods, increasing food insecurity.

The effects on public health in Nuiqsut may be highly adverse and disproportionately borne by the Nuiqsut population.

3.17.3.4 Alternative C: Disconnected Infield Roads

Effects to subsistence, sociocultural systems, and public health under Alternative C would be similar to those described under Alternative B. Although this alternative reduces effects to caribou resource availability, it has a larger overall footprint and a higher level of air traffic.

The effects on subsistence, sociocultural systems, and public health may be highly adverse and would be disproportionately borne by the Nuiqsut population.

3.17.3.5 Alternative D: Disconnected Access

Effects to subsistence, sociocultural systems, and public health under Alternative D would be similar to those described under Alternative B. This alternative would have the least impact to caribou availability. This would eliminate the potential for subsistence harvesters to access new areas via road and would increase the level of air traffic, adding to the adverse effects.

The effects on subsistence, sociocultural systems, and public health may be highly adverse and would be disproportionately borne by the Nuiqsut population.

3.17.3.6 Module Delivery Options

3.17.3.6.1 Option 1: Proponent's Module Transfer Island

Option 1 impacts to environmental justice would be similar to those described for Alternative B and would be disproportionately high and adverse for Nuiqsut residents as they are the minority population located closest to the MTI. Because Atigaru Point is a high subsistence use area for caribou for Nuiqsut residents (Figure 3.16.15) and is an important traditional caribou hunting ground, the most substantial Option 1 impacts are related to subsistence and sociocultural systems.

3.17.3.6.2 Option 2: Point Lonely Module Transfer Island

Some of the effects for Option 2 would be similar to those of Option 1, because the gravel mine site would be the same under both options. Effects of Option 2 would be substantially less for Nuiqsut than for Option 1, because the MTI and the majority of the ice roads would be outside of the community's core subsistence use area. The subsistence effects from Option 2 would not be highly adverse or disproportionately borne by the Nuiqsut population.

3.17.3.7 Oil Spills and Accidental Releases

Effects of oil spills and other accidental releases would be disproportionately borne by Nuiqsut residents. Project use and storage of hazardous materials throughout the life of the Project could reduce the use of fish resources if fish or the streams they inhabit are perceived or confirmed to be contaminated, causing some individuals to avoid harvesting fish resources downstream from drill sites and pipelines. The level of avoidance and impacts on the community would vary by individual and their sensitivity to development.

Large spills that escape gravel pads and spread on the tundra or in rivers would have the most adverse effect on Nuiqsut residents and their access to subsistence resources. Although the effect of a large spill would be highly adverse in the immediate aftermath of the spill, there is a low probability of a spill of this extent over the life of the Project. The effects of a large oil spill that travels off gravel pads may be highly adverse and would be disproportionately borne by the Nuiqsut population, but there would be a very low probability of a large spill event occurring.

3.17.4 Measures Taken to Avoid or Minimize Disproportionate and Environmental Justice Impacts

Prior planning documents covering the Project area (BLM 2004a, 2008a, 2012b, 2013a, 2014a) have provided opportunities for public involvement for low-income and minority populations. The BLM has carefully considered community views when developing and implementing mitigation strategies to reflect the needs and preferences of these populations, to the extent practicable. These planning documents have made some lands unavailable for oil and gas leasing, including a large portion of the ACP within the NPR-A used by Nuiqsut subsistence users.

Following scoping for the Willow Project, the BLM conducted a series of alternatives development workshops with the cooperating agencies, including the Native Village of Nuiqsut and the City of Nuiqsut. Each agency provided expertise and assisted BLM in identifying alternatives and ways to avoid or minimize potential Project impacts, with a focus on minimizing impacts identified in scoping, such as impacts to caribou and other terrestrial wildlife, as well as other subsistence impacts.

As part of the alternatives development process, potential alternatives were evaluated using screening criteria, which included consideration of whether the alternative reduced adverse impacts or resource conflicts. As a result, each alternative's ability to do the following was considered:

- Reduce the overall Project footprint (i.e., direct impacts from facilities).
- Reduce potential human health impacts (especially those relating to air quality and subsistence).
- Reduce impacts to wildlife, subsistence resources (especially caribou), and subsistence use areas.
- Reduce risks related to spills or other accidental releases.
- Reduce effects to water resources and floodplains, including marine habitat.

For more detailed information on alternatives development and avoidance and minimization of impacts, see Chapter 2.0, *Alternatives,* and Appendix D, *Alternatives Development*. The Proponent's design features to avoid and minimize impacts are detailed in Appendix I.1, *Avoidance, Minimization, and Mitigation*. The Project would increase the amount of funds available to Nuiqsut through the NPR-A Impact Mitigation Fund (described in Section 5.3.1, *State of Alaska National Petroleum Reserve in Alaska Impact Mitigation Program*). CPAI provides the City of Nuiqsut access to a grant writer to assist with grant proposals, which could increase the local understanding that mitigation funds are available and decrease some concerns over the impacts of the Project. CPAI also provides funding for accounting support, which is critical to successfully managing grant money.

3.17.5 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1. Project impacts, particularly on subsistence harvester access or subsistence resource availability, may be highly adverse and would be disproportionately borne by the Nuiqsut population. To address community concerns and further reduce disproportionate impacts, the following additional mitigation measures are recommended:

1. Establish a Nuiqsut coordination group (or continue to use the Kuukpikmuit Subsistence Oversight Panel) to continue meaningful engagement in the Project and identify continuing concerns and specific Project impacts. Determine a schedule for periodic meetings to present concerns to CPAI and discuss potential resolution strategies.
2. Conduct community outreach programs to inform the Nuiqsut community about Project decisions and impacts, address user concerns, identify topics for additional review, and determine possible solutions for implementation.
3. Provide regular Project updates to the community and leadership in Nuiqsut throughout construction and operations.

3.17.6 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Environmental justice impacts described above would be unavoidable and irretrievable during the life of the Project. If reclamation did not occur, effects would be irreversible. Effects may not be irreversible in terms of subsistence access and harvest areas if reclamation of gravel roads and pads occurs and wildlife migration patterns are not permanently changed. However, multi-generational shifts in sociocultural values due to shifts in subsistence participation and passing on of subsistence traditions may be irreversible depending on the extent of changes to harvester access, wildlife availability, and local community response to the Project. For more vulnerable sectors of the Nuiqsut population, this could affect the long-term sustainability of the subsistence traditions in the area.

3.17.7 Environmental Justice Determination

All of the action alternatives and module delivery Option 2 would result in disproportionately high and adverse environmental effects to the minority community of Nuiqsut. There are sub-populations within this minority population that may experience the impacts of the Project differently than the rest of the community. Lower economic status households and households that are more dependent on harvesting subsistence resources from impacted use areas could experience more intense impacts. However, some individuals and households would likely experience positive impacts from the facilitated access provided by Project roads.

The finding of the Alaska National Interest Lands Conservation Act Section 810 subsistence evaluation (Appendix G, *ANILCA 810 Analysis*) is that the Project may significantly restrict subsistence uses for the community of Nuiqsut under all action alternatives due to a reduction in the availability of resources caused by alteration of their distribution, and a limitation on subsistence user access to the area. An ANILCA Section 810 notice will be published concurrent with the EIS and a public hearing will be held in Nuiqsut during the public meeting for the Draft EIS.

Reduced subsistence resource availability, as well as reduced harvester access through access restrictions and through avoidance, would adversely affect subsistence and sociocultural systems. Decreased subsistence resource availability and harvester access would also adversely affect sociocultural systems due to the importance of subsistence in Iñupiaq cultural identity, social organization, social cohesion, transmission of cultural values, and community and individual well-being.

3.18 Public Health

The geographic extent of the public health analysis is limited to the community of Nuiqsut, the closest community to the Project, which is approximately 25 miles from the nearest proposed drill site. Nuiqsut residents use the CRD and the NPR-A, including the Project area, for subsistence harvests and other reasons. The temporal scale for Project impacts to public health is defined as the life of the Project or until long-term public health effects are mitigated to their original conditions following Project reclamation.

This analysis tiers to information contained in the NPR-A IAP/EIS (BLM 2012b, Section 4.4.21), which presented a broad-based assessment of potential health effects associated with oil and gas development on the North Slope.

3.18.1 Affected Environment

The NSB and Nuiqsut residents have expressed concerns about the potential for public health effects associated with oil and gas development on the North Slope, including impacts from air emissions, water quality changes, and the potential for spills to contaminate the environment and subsistence resources that Nuiqsut residents rely on (BLM 2018d). Technical guidance for evaluating health impacts from resource development projects was provided by the following:

- Alaska Department of Health and Social Services (ADHSS), *Alaska Health Impact Analysis Technical Guidance* (2015)
- NSB, *Health Impact Assessment for Natural Resource Development in Alaska Collaborative Guidance* (2015b)
- BLM, *National Petroleum Reserve in Alaska Integrated Activity Plan/Environmental Impact Statement* (2012b) health effects analysis

This analysis uses the eight ADHSS health effects categories (HECs) to evaluate potential health effects on the local population from the Project. These HECs incorporate issues identified in the NSB guidance (2015b) and those factors evaluated in BLM (2012b). HECs are described in Tables E.18.1 and E.18.2 in Appendix E.18, *Public Health Technical Appendix*.

Because Nuiqsut's small population limits the availability of public health data, this analysis uses public health statistics for the NSB, supplemented with data from community health baseline assessment reports in 2012 and 2014 (Habitat Health Impact Consulting 2014; McAninch 2012); these studies rely heavily on 2010 NSB survey data for village-level statistics (NSB 2011).

3.18.1.1 Health Effects Category 1: Social Determinants of Health

The HEC 1 components that the Project may affect include employment, economic status, social connections/cultural continuity, mental health, and overall general health.

Employment: Employment opportunities in Nuiqsut are limited and unemployment is high (Section 3.15, *Economics*). U.S. Census statistics provide an unemployment rate in Nuiqsut (19.8%) that is more than twice that of Alaska overall (7.8%) (U.S. Census 2018b). The NSB estimates that unemployment in Nuiqsut is even higher at 36.5% (NSB 2016).

Economic status: The economic status of Nuiqsut is described in Section 3.15. National and local statistics on economic indicators differ substantially, but the consensus is that the cost of living in Nuiqsut is much higher than in urban Alaska. In addition, local challenges related to the availability or costs (or both) of housing, employment, food products, and health services result in the economic status for Nuiqsut residents being more difficult to place in context using state and national statistics.

Social connections/cultural continuity: Cultural continuity includes the continuation of subsistence activities, including harvesting resources and sharing those resources within the community, as well as using and teaching the Iñupiaq language. Cultural continuity is strong in Nuiqsut. ADF&G characterizes Nuiqsut as "a highly active, subsistence-based community" with 95% of Nuiqsut households attempting to harvest subsistence resources in 2014 (ADF&G 2016a). The NSB 2010 socioeconomic survey data indicate that 54% of Nuiqsut Iñupiat households had at least one fluent Iñupiaq speaker (NSB 2016). Nuiqsut was the only NSB community that showed an increased percentage of fluent Iñupiaq speakers between 2003 and 2010 (NSB as reported in Habitat Health Impact Consulting 2014).

Mental health: State 2017 health statistics show that Alaska Natives report more mentally unhealthy days per month (4.3) than Alaskans as a whole (3.9) (ADHSS 2019c). State statistics comparing all North Slope and Alaska Native North Slope residents show Alaska Native residents report 3.5 mentally unhealthy days per month versus 3.2 for all North Slope residents (ADHSS 2019c).

General health: State health statistics for 2017 show that 16.9% of Alaskans reported poor to fair health compared to 24.8% of Alaska Natives (ADHSS 2019b). On the North Slope, 13.1% of all residents reported poor to fair health in 2017, while 14.2% of Alaska Natives on the North Slope reported poor to fair health (ADHSS 2019b).

3.18.1.2 Health Effects Category 2: Accidents and Injuries

The unintentional injury mortality rate for Alaska Natives in 2016 was 115.1 per 100,000 people, 175% higher than the rate for all Alaskans (61.9) (ADHSS 2019d). NSB mortality rates from unintentional injury from 2012 through 2016 (86.3) also exceeds the comparable statewide rate (65.1) (ADHSS 2019d).

3.18.1.3 Health Effects Category 3: Exposure to Potentially Hazardous Materials

Air quality: As discussed in Section 3.3, *Air Quality*, studies have found that air pollutant concentrations in Nuiqsut were below NAAQS and Alaska Ambient Air Quality Standards (AAAQS) for most measured pollutants (ADHSS 2012; ANTHC 2011). Particulate matter 2.5 and 10 ($PM_{2.5}$ and PM_{10}) levels have exceeded NAAQS and AAAQS on a few occasions, although this is common in rural Alaska communities during the summer months when windborne dust is generated from gravel roads and exposed riverbanks. Air quality sampling has indicated no violations of air quality standards or federal agency screening levels for volatile organic compounds (ANTHC 2011).

Water quality: As discussed in Section 3.8, *Water Resources*, a 2011 water quality study evaluated volatile organic compound levels in local surface waters, and no samples had concentrations exceeding state water quality standards (ANTHC 2011). Nuiqsut's drinking water supply had detectable levels of xylene in the early 2000s when a new water storage tank's liner failed to properly cure. Water quality was monitored quarterly as the levels decreased and monitoring returned to an annual basis in 2005. The detected xylene levels are below the USEPA limits established for drinking water to protect public health (ADEC 2018c). Overall, water quality near Nuiqsut is good.

Subsistence: As described in Section 3.16, *Subsistence and Sociocultural Systems*, Nuiqsut has a high percentage of subsistence users. NSB studies conducted to date have found that contaminant levels in subsistence resources tested were below levels of concern for human health (NSB 2018a).

3.18.1.4 Health Effects Category 4: Food, Nutrition, and Subsistence Activities

Food and nutrition: The 2015 NSB survey classified households as "food insecure" if they indicated not having enough to eat at times. The survey results indicated that, overall, 24% of NSB Iñupiat households surveyed were food insecure compared to 9% of Iñupiat households in Nuiqsut (NSB 2016).

Subsistence activities: Between 2003 and 2010, Nuiqsut was the only NSB community that reported an increase in the percentage of households for which subsistence foods accounted for more than half of the household's diet (McAninch 2012). Among all NSB communities, a higher percentage of Nuiqsut households use subsistence resources for more than half of their diet (NSB 2016).

3.18.1.5 Health Effects Category 5: Infectious Disease

Infectious disease rates for Alaska Natives are lower than those for all Alaskans for most diseases, but Alaska Natives have higher rates of hospitalization for upper and lower respiratory diseases and cellulitis (Gounder, Holman et al. 2016). Rates of chlamydia (a sexually transmitted disease) are higher in Alaska Natives (2,516 per 100,000) than statewide (770 per 100,000), and rates are highest in southwest and northern Alaska (ADHSS 2019a).

3.18.1.6 Health Effects Category 6: Water and Sanitation

About 90% of Nuiqsut households are connected to sanitary sewage facilities. About 94% of Nuiqsut households are connected to the village drinking water system (NSB 2015c).

3.18.1.7 Health Effects Category 7: Non-Communicable and Chronic Diseases

Nuiqsut residents reported higher levels of heart disease, chronic pain or arthritis, and chronic ear problems, and a lower level of chronic breathing problems (7%) compared to the levels reported in the NSB overall (8%) (McAninch 2012). For breathing problems in children, however, the reported percentage was higher in Nuiqsut (8%) than for the NSB overall (5%) (McAninch 2012). More than two-thirds (69%) of Nuiqsut Iñupiat household heads reported smoking in 2015 compared to 67% in the NSB overall (NSB 2016).

3.18.1.8 Health Effects Category 8: Health Services Infrastructure and Capacity

The NSB and the Arctic Slope Native Association provide health-care services in all NSB communities with health aides who are not medical professionals (Habitat Health Impact Consulting 2014). Nuiqsut has a primary care health clinic, but advanced care must be accessed in Utqiaġvik (Barrow) (150 miles), Fairbanks (350 miles), or Anchorage (600 miles), and requires air travel. Therefore, the NSB is characterized as a medically underserved community by the U.S. Health Resources and Services Administration (McAninch 2012).

Nuiqsut had an average of 24.1 **medevacs** per 100 people from 2005 to 2008, which was slightly lower than the average (26) for NSB villages (McAninch 2012).

3.18.2 Environmental Consequences

3.18.2.1 Applicable Existing Lease Stipulations and Best Management Practices

Table 3.18.1 summarizes existing LSs and BMPs that would apply to the Project and are intended to mitigate impacts to public health from development (BLM 2013a). The LSs and BMPs would reduce or minimize impacts to public health in the areas of environmental exposure, nutrition, diet, and acculturative stress through subsistence consultation, orientation programs and implementation of Project waste prevention, handling, disposal and spill response procedures to reduce or eliminate exposure.

Table 3.18.1. Summary of Applicable Existing Lease Stipulations and Best Management Practices Intended to Mitigate Impacts to Public Health

LS or BMP	Description or Objective	Requirement
BMP A-1	Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, state, and local law and regulations	Areas of operation shall be left clean of all debris.
BMP A-2	Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.	Prepare and implement a comprehensive waste management plan for all phases of development. Wastewater and domestic wastewater discharge to waterbodies and wetlands is prohibited unless authorized by a National Pollutant Discharge Elimination System or State permit.
BMP A-1	Minimize pollution through effective hazardous-materials contingency planning.	A hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances.
BMP A-4	Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.	Develop a comprehensive spill prevention and response contingency plan.
BMP A-5	Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.	Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any waterbody.
BMP A-7	Minimize the impacts to the environment from disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.	Discharge of produced water in upland areas and marine waters is prohibited.

LS or BMP	Description or Objective	Requirement
BMP A-8	Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.	Prepare and implement bear-interaction plans to minimize conflicts between bears and humans.
BMP A-9	Reduce air quality impacts.	All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel.
BMP A-10	Prevent unnecessary or undue degradation of the lands and protect health.	Air monitoring, emissions inventory, emissions reduction plan, air quality modeling, and possibly mitigation measures.
BMP A-11	Ensure that permitted activities do not create human health risks through contamination of subsistence foods.	Design and implement a monitoring study of contaminants in locally used subsistence foods.
BMP E-1	Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.	All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
LS E-2	Protect fish-bearing waterbodies, water quality, and aquatic habitats.	Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet from the ordinary high-water mark of fish-bearing waterways.
LS E-3	Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.	Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas.
BMP E-4	Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.	All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan.
BMP E-5	Minimize impacts of the development footprint.	Facilities shall be designed and located to minimize the development footprint.
BMP E-6	Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.	Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow.
BMP E-7	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.
BMP E-8	Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.	Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer and in consultation with appropriate federal, state, and North Slope Borough regulatory and resource agencies.
BMP E-9	Minimize disruption of caribou movement and subsistence use.	Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities.
BMP E-10	Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.	Illumination of all structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.
BMP F-1	Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.	Ensure that aircraft used for permitted activities maintain altitudes specified in guidelines. See Appendix I.1, *Avoidance, Minimization, and Mitigation,* for specific BMP F-1 guidelines.
BMP H-1	Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.	Consult with affected communities per guidelines.
BMP H-3	Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.	Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status."
BMP I-1	Minimize cultural and resource conflicts.	All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region and attend an orientation once a year.

Source: BLM 2013a
Note: BLM (Bureau of Land Management); BMP (best management practice); LS (lease stipulation)

All action alternatives would require deviations from existing LSs and BMPs, as detailed in Table D.4.4 (Anticipated Deviations from National Petroleum Reserve in Alaska Best Management Practices) in Appendix D, *Alternatives Development*. Deviations that would affect public health would include those to LS E-2 and BMP E-5 and E-7. All action alternatives include road and pipeline crossings of fish-bearing waterbodies (including one or more of the waterbodies protected in LS E-2 and BMP K-1) and freshwater intake pipelines at Lakes M0015 and R0064 (Figure 3.10.2, in Section 3.10, *Fish*). As a result, it is not possible in all instances to avoid encroachment within 500 feet of every waterbody. BMP E-5 would require a deviation because all alternatives would place new VSMs along existing pipeline corridors due to pipe rack capacity limits; and would separate the proposed airstrip(s) from roads due to Federal Aviation Administration regulations and operational safety concerns based on incident history at the Alpine integrated airstrip.

Lastly, it may not be feasible in all areas to maintain a minimum distance of 500 feet between pipelines and roads (BMP E-7), due to road and pipeline design constraints. Deviations would occur where roads and pipelines converge on a drill site pad or at narrow land corridors between lakes where it is not possible to maintain 500 feet separation between pipelines and roads without increasing potential impacts to waterbodies.

3.18.2.2 Alternative A: No Action

Alternative A would have no new effects on public health in Nuiqsut. Nuiqsut residents are likely to continue to have limited access to advanced medical care and higher rates of some health issues, such as upper and lower respiratory illnesses.

3.18.2.3 Alternative B: Proponent's Project

3.18.2.3.1 Construction Phase

3.18.2.3.1.1 Health Effects Category 1: Social Determinants of Health

Employment: Construction activities would result in additional employment opportunities in Nuiqsut. Although most construction jobs would be filled by non-locals, even a small number of additional jobs would positively impact the community's relatively small labor force.

Economic status: Household incomes in Nuiqsut rely heavily on wage income and dividends from ANCSA corporations (Section 3.16, *Subsistence and Sociocultural Systems*). Project construction would increase household incomes for Nuiqsut residents employed with Project construction jobs, and dividend income would also increase for ASRC and Kuukpik shareholders if these corporations have subsidiaries working on Project construction.

Social connections/cultural continuity: Few non-local construction workers would be expected to interact with Nuiqsut residents. If Nuiqsut residents are hired and stay in Project camps, they would have more interaction with non-local workers, decreased connections with their social support network, and potential time conflicts for subsistence activities. Not all Nuiqsut residents would find jobs or receive ANCSA dividends, resulting in the potential for social tensions regarding an uneven distribution of money in the community (McAninch 2012). Cultural continuity would be impacted if subsistence activities were interrupted by construction activities that could restrict access to subsistence harvest areas or decrease subsistence resource availability.

Mental health: Construction activities would result in increased air and noise emissions, including in currently undeveloped areas Nuiqsut residents use or travel through. This would increase stress in some Nuiqsut residents and could lead to or exacerbate mental health issues such as anxiety and depression. Residents who apply for jobs and are not hired may also experience these conditions.

General health: Construction would not affect general health in Nuiqsut.

3.18.2.3.1.2 Health Effects Category 2: Accidents and Injuries

Construction activities could result in an increased potential for accidents and injuries for Nuiqsut residents. Construction activity could result in changes in local travel patterns and use of new travel routes would increase the potential for accidents and injuries, particularly if residents must travel farther or along unfamiliar routes.

3.18.2.3.1.3 Health Effects Category 3: Exposure to Potentially Hazardous Materials

Air quality: Most Project construction activities would occur over 20 miles from Nuiqsut. Prevailing winds would typically blow equipment emissions and dust to the southwest, away from Nuiqsut, so construction activities would not impact air quality in the community.

Water quality: Contractors working on the Project would be required to develop and comply with stormwater pollution prevention plans to avoid or minimize pollutant discharge to waters. No effects on water quality are expected.

Subsistence: Section 3.16, *Subsistence and Sociocultural Systems,* discusses the potential adverse effects on subsistence during construction and Chapter 4.0, *Spill Risk Assessment,* provides an analysis of potential spills and their likelihood during construction. Construction-related impacts to subsistence resources could occur for a limited time primarily from potential hazardous material spills. Potential construction spill locations could include marine waters, ice and gravel infrastructure locations, and the Tiŋmiaqsiuġvik mine site. Most spills would be expected to be very small to small, localized, and contained quickly. However, because subsistence resources are expected to be displaced, diverted away from, or avoid the construction area (due to the increased human activity, traffic and noise) they would likely not be exposed to hazardous materials.

3.18.2.3.1.4 Health Effects Category 4: Food, Nutrition, and Subsistence Activities

Food and nutrition: Section 3.16, *Subsistence and Sociocultural Systems,* describes potential adverse effects on subsistence. Reduced subsistence harvests would adversely affect community health by reducing the availability of subsistence foods and increasing dependence on store-bought foods, increasing food insecurity. Increased incomes for some households would provide funds to support subsistence activities and allow for the purchase of more store-bought foods, potentially offsetting some adverse effects on food insecurity during Project construction.

Subsistence activities: Section 3.16, *Subsistence and Sociocultural Systems,* describes the potential adverse effects on subsistence, including changes in traditional means of access and potential harvester avoidance of Project construction areas.

3.18.2.3.1.5 Health Effects Category 5: Infectious Disease

Non-local construction workers would have little contact with Nuiqsut residents, and construction would not affect infectious disease levels in the community.

3.18.2.3.1.6 Health Effects Category 6: Water and Sanitation

There would be no effect on drinking water or sanitation for Nuiqsut.

3.18.2.3.1.7 Health Effects Category 7: Non-Communicable and Chronic Diseases

Construction activities would not directly affect non-communicable or chronic disease levels in Nuiqsut, although construction activities could increase stress levels for some Nuiqsut residents, increasing disease susceptibility.

3.18.2.3.1.8 Health Effects Category 8: Health Services Infrastructure and Capacity

Non-local construction workers would be housed at construction camps and would have access to on-site medical facilities and transportation to an urban area for advanced medical treatment, if needed. There would be no effect on community health services in Nuiqsut.

3.18.2.3.2 Operations and Drilling Phases

Operations and drilling activities would have the same effects described above for construction, except the duration of the effects would continue for the life of the Project (through 2050). If subsistence harvest and sharing activities are disrupted for the long term, effects on cultural connectivity and social connections would last beyond the life of the Project. Similarly, if residents' stress levels increase due to increased concerns about subsistence access and harvests, the inequality of positive impacts from development and contamination of subsistence resources, air, and water, the increased stress could become chronic and indirectly contribute to poorer overall health for some residents.

3.18.2.4 Alternative C: Disconnected Infield Roads

Effects for this alternative would be the same as described for Alternative B. As noted in Section 3.16, the removal of some roads results in reduced impacts on some subsistence resources and increased impacts on others due to increased flight activity. Overall, the effects on food, nutrition, and subsistence (HEC 4) social connections and cultural continuity (HEC 1) would be somewhat less but not substantially different than Alternative B. Effects on accidents and injuries (HEC 2) may be less given the reduced potential for conflicts with road traffic, but still greater than Alternative D.

3.18.2.5 Alternative D: Disconnected Access

Effects for this alternative would be the same as described for Alternative C. Elimination of the access road may reduce some subsistence impacts but may also result in more flight activity. Overall, the effects on food, nutrition, and subsistence (HEC 4) and social connections and cultural continuity (HEC 1) would be somewhat less but not be measurably different from Alternatives B and C. With no access road, the potential for accidents and injuries (HEC 2) may be reduced compared to Alternatives B and C.

3.18.2.6 Option 1: Proponent's Module Transfer Island

Effects on public health related to the MTI would primarily result from adverse effects on food, nutrition, and subsistence (HEC 4) and related effects on social connections and cultural continuity (HEC 1) due to the impacts on subsistence described in Section 3.16, *Subsistence and Sociocultural Systems*. This option would have more adverse impacts on Nuiqsut subsistence harvests, particularly of caribou and a more limited effect on Utqiaġvik subsistence harvesters.

3.18.2.7 Option 2: Point Lonely Module Transfer Island

Effects on public health from Option 2 would not be measurably different from Option 1. This option would affect subsistence harvesters from Nuiqsut less and would affect Utqiaġvik subsistence harvesters more, particularly caribou harvesters.

3.18.2.8 Oil Spills and Accidental Releases

Most spills and accidental releases would be small and would occur on gravel pads or other developed areas. These spills would not affect public health in Nuiqsut. Larger spills that could occur and spills that migrate off gravel pads have the potential to contaminate land, water, and subsistence resources such as fish. State and national spill response regulations require oil field operators to have plans for spills that limit exposure to fish and wildlife and limit public exposure to the spill area or hazardous materials associated with cleanup activities. Response activities could also increase air emissions from increased transport of labor and equipment into the spill area and increased use of equipment in cleanup activities. Community concerns about potential spills, contamination of water and subsistence resources, and additional noise and activities associated with spill response could increase stress levels in community residents during and after response activities.

3.18.3 Additional Suggested Best Management Practices or Mitigation

All existing NPR-A IAP LSs and BMPs would be implemented. CPAI's design features to avoid or minimize impacts are listed in Table I.1.2. (Design Features to Avoid and Minimize Impacts) of Appendix I.1, *Avoidance, Minimization, and Mitigation*. There are no additional suggested mitigation measures.

3.18.4 Unavoidable Adverse, Irretrievable, and Irreplaceable, Effects

Effective implementation of BMPs for resources that influence public health (air quality, noise, sociocultural systems, subsistence, etc.) would help prevent unavoidable adverse, irretrievable, and irreversible effects to public health. They would also provide for the long-term sustainability of public health in the analysis area.

In addition, limited health data is available for Nuiqsut. The best data available date from the NSB's 2010 survey. Funding a collection of health information for Nuiqsut and studies of contaminant levels in local subsistence resources would provide better data for evaluation of potential health effects associated with oil field development and operation.

3.19 Cumulative Effects

3.19.1 Introduction

The cumulative effects analysis considers impacts of a proposed action and its alternatives that may not be consequential when considered individually, but when combined with impacts of other actions, may be consequential (CEQ 1997). A cumulative impact is an "…impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency…or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7 and 1508.25[a][2]).

The purpose of this cumulative effects analysis is to determine if the impacts of the Project, together with other past, present, and reasonably foreseeable future actions, have the potential to accumulate over time and space, either through repetition or combination with other impacts, and what the effects of that accumulation would be.

3.19.2 Background and Methodology

3.19.2.1 Background

The cumulative effects analyses are documented in multiple EISs for similar types of projects and programs on the North Slope: the *Coastal Plain Oil and Gas Leasing Program Draft EIS* (BLM 2018b, Chapter 3), *GMT-2 Supplemental Final EIS* (BLM 2018a, Section 4.6), and *Nanushuk Project EIS* (USACE 2018, Section 3.1.3, and throughout Chapter 3) provide a broad analysis of existing and potential oil and gas-related activities on the North Slope that is applicable to the cumulative impacts analysis for the Willow MDP. The cumulative impacts summaries and conclusions in the above-referenced EISs were reviewed for the applicability of information and methods to the Project; then past, present, and reasonably foreseeable future actions affecting the resources evaluated in this EIS were identified and evaluated.

3.19.2.2 Methodology

The analysis of cumulative impacts follows guidance provided in Considering Cumulative Effects under NEPA (CEQ 1997). Past, present, and reasonably foreseeable future actions that may impact the elements of the environment already potentially impacted by the Project were identified and evaluated. Cumulative effects of oil and gas exploration and development action on the North Slope have been extensively evaluated in multiple EISs. The cumulative impacts analytical method for resources analyzed in this EIS was similar in approach to those described in detail by the BLM (BLM 2018a, 2018b) and the USACE (2018).

The BLM considered public and agency input (Appendix B) and used the technical analyses conducted for this EIS to identify and focus on cumulative effects that are "truly meaningful" in terms of local, regional, or national significance (CEQ 1997). This EIS addresses the direct and indirect effects of alternatives on the range of resources representative of the human and natural environment; for this cumulative effects analysis similar resources have been grouped. While not all of those resources need to be included in the cumulative effects analysis—just those that are relevant to the decision to be made on the proposed action—the grouping provides a summary of cumulative impacts to all resources.

The temporal scope of cumulative impacts analysis is the 1970s (when oil and gas activities began on a large scale on the North Slope) through the anticipated duration of direct and indirect impacts from the Project (assumed to be 30 years after the Project has ended and gravel infrastructure is removed [detailed in Section 3.9, *Wetlands and Vegetation*]), which would be 2081. The geographic scope of cumulative impacts analysis is the analysis area for each resource (Sections 3.2 through 3.19, the resource analysis sections). Climate change impacts (as described in Section 3.2, *Climate and Climate Change*) are occurring as a result of factors well beyond the North Slope. Nevertheless, a changing climate affects all resources assessed in the EIS and the effects of climate change are incorporated as a future condition as part of the assessment of affected environment and cumulative effects.

3.19.3 Past, Present, and Reasonably Foreseeable Future Actions

Past and present actions are described in Section 3.1, *Introduction and Analysis Methods*, and in Figure 3.19.1. Reasonably foreseeable future actions considered in this cumulative impacts analysis are presented in detail in Table 3.19.1 and in Figure 3.19.2. Impacts of RFFAs that are the farthest from BT3 (the center of the Project) would overlap with impacts from the Project in three primary areas: overall subsistence uses, caribou movement, and greenhouse gas emissions contributions to climate change.

Past and present actions that were considered were mainly oil and gas exploration and development actions on the North Slope that have environmental impacts within the analysis area of the resources analyzed in this cumulative effects analysis. Reasonably foreseeable future actions include oil and gas exploration, pipeline development, and transportation projects that are likely to affect resources in similar ways as the Project.

Table 3.19.1. Reasonably Foreseeable Future Actions that may Interact with the Project

Type	Project	Entity	Description	Unit/ Location	Distance to BT3[a] (miles)
Oil and Gas Exploration and Development	Nanushuk	Oil Search Alaska	New oil and gas development east of the Colville River. USACE ROD May 2019; construction estimated to begin late 2019	Pikka Unit	35
Oil and Gas Development	Nuna DS2	Eni Petroleum	Nuna DS1 gravel infrastructure was constructed 2015 and is included as a present project; a second drill site (DS2) is permitted may be constructed in the future	Kuparuk River Unit	46
Oil and Gas Exploration and Development	Mustang	Brooks Range Petroleum Company	Exploration wells and gravel infrastructure; project suspended ~2014 due to funding issues; may be active again at any point	Southern Miluveach Unit	45
Oil and Gas Exploration	Miscellaneous Seismic Exploration	Multiple	Seismic exploration is ongoing throughout the region; conducted by multiple firms for different operators	Multiple	Varies
Oil and Gas Exploration and Development	Liberty	Hilcorp Alaska	Proposed manmade island located northeast of Deadhorse. BOEM published ROD on October 26, 2018.	Liberty	108
Oil and Gas Exploration and Development	Greater Willow 1 & 2	ConocoPhillips Alaska Inc.	Potential expansion areas to be included in the Willow Master Development Plan	Bear Tooth Unit	8
Oil and Gas Development	Kuparuk Seawater Treatment Plant Upgrades	ConocoPhillips Alaska Inc.	Planned upgrades to the existing treatment plant at Oliktok Point	Kuparuk River Unit	61
Oil and Gas Development	Alaska LNG	State of Alaska	Natural gas line from North Slope to Nikiski; includes compression and liquification facilities	North Slope	89
Oil and Gas Development	Alaska Stand Alone Pipeline	State of Alaska	Natural gas pipeline for in-state distribution that would follow the Trans-Alaska Pipeline System from the gas conditioning facility in Prudhoe Bay south to a connection with the existing ENSTAR natural gas pipeline system in the Matanuska-Susitna Borough	North Slope	89
Oil and Gas Exploration and Development	Arctic National Wildlife Refuge Oil and Gas Leasing Program	BLM	Oil and gas leasing program for the Arctic National Wildlife Refuge in Area 1002	Arctic National Wildlife Refuge	140
Transportation	Colville River Access Road	Nuiqsut/North Slope Borough	Proposed gravel road connecting water source lake to Colville River; Road permitted in 2016	Nuiqsut	28
Transportation	Arctic Strategic Transportation and Resources (ASTAR) Project	State of Alaska/ North Slope Borough	Planning level effort to identify North Slope community needs; includes potential roads (seasonal ice, snow, or all-season gravel) that may connect communities to the Dalton Highway	North Slope	Unknown
Oil and Gas Exploration and Development	NPR-A Integrated Activity Plan Revisions	BLM	Revisions to the IAP for NPR-A, including potentially opening areas to oil and gas leasing and development	NPR-A	0

Note: BLM (Bureau of Land Management); BOEM (Bureau of Ocean and Energy Management); BT3 (Bear Tooth drill site 3); DS (drill site); IAP (Integrated Activity Plan); LNG (liquified natural gas); NPR-A (National Petroleum Reserve in Alaska); ROD (record of decision); USACE (U.S. Army Corps of Engineers); IAP (Integrated Activity Plan). A reasonably foreseeable future project is defined as a project for which there is an existing proposal, a project currently in the NEPA process, or a project to which a commitment of resources (such as funding) has been made. For the EIS, we assume all present projects will also occur in the future; present projects are not listed in the table.

[a] BT3 is the center of the Willow Project; distances measured from BT3 to closest point of other projects.

3.19.4 Cumulative Impacts to Climate Change

As part of the required Greenhouse Gas Reporting Program, the USEPA requires all facilities that emit more than 25,000 metric tons of CO_2e per year to report their annual GHG emissions. This information is collated in the USEPA's (2019a) Facility Level Information on Greenhouse Gases Tool. The total CO_2e emissions from all major sources on the North Slope are listed in Table 3.19.2. As with Alaska as a whole, the industrial sector, including oil and gas industries, is the major contributor to GHG emissions in the North Slope.

Cumulative GHG emissions include Willow direct and indirect emissions, existing GHG emissions sources on the North Slope (presented in Table 3.19.2), and GHG emissions from the Greater Willow potential drill sites 1 and 2 (Figure 3.19.2). Together the cumulative annual average GHG emissions are approximately 0.1% of the 2017 U.S. GHG inventory for all action alternatives.

Table 3.19.2. North Slope Major Facility Greenhouse Gas Emissions in Year 2015[a]

Facility Name	CO_2e (metric tons)[b]
BPXA Central Compressor Plant	2,767,897
BPXA Central Gas Facility	2,011,855
BPXA Central Power Station	780,970
Endicott Production Facility	718,112
BPXA Lisburne Production Center	701,550
BPXA Flow Station 3	606,554
ConocoPhillips Alaska Inc – KRU CPF1	531,888
BPXA Flow Station 2	453,913
BPXA Gathering Center 1	406,471
ConocoPhillips Alaska Inc – KRU CPF2	402,552
BPXA Flow Station 1	385,445
BPXA Gathering Center 2	374,232
Northstar Prod Facility	359,332
ConocoPhillips Alaska Inc – KRU CPF3	318,929
BPXA Gathering Center 3	302,850
BPXA Seawater Injection Plant	189,298
Milne Point Production Facility, Central Facility Pad and E-Pad	168,335
BPXA Seawater Treatment Plant	108,559
ConocoPhillips Alaska Inc – KRU Saltwater Treatment Plant	90,229
Alyeska Pipeline SE/Taps Pump Station 1	85,080
Trans Alaska Pipeline System Pump Station 4	77,713
Trans Alaska Pipeline System Pump Station 3	75,811
Barrow Utilities & Electric	43,586
BPXA Crude Oil Topping Unit, Prudhoe Bay Operations Center, Tarmac Camp	28,568
Total	**11,989,729**

Note: BPXA (British Petroleum Exploration Alaska, Inc.); CO_{2e} (carbon dioxide equivalent); CPF (central processing facility); KRU (Kuparuk River unit)
[a] USEPA Facility Level Information on Greenhouse Gases Tool (2019a)
[b] CO_2e calculated using global warming potential values from Table E.2.1 in Appendix E.2A, *Climate and Climate Change Technical Appendix*.

3.19.5 Cumulative Impacts to Air Quality

Effects of past and present actions on air quality have resulted in the affected environment presented in Section 3.3, *Air Quality*. Section 3.3.2, *Environmental Consequences,* includes additional planned developments and background air quality concentrations in order to compare total air quality and AQRV conditions to applicable standards. Therefore, results presented in that section include a cumulative impact assessment. Table 3.19.3 presents the past, present, and RFFAs that were considered in the modeling analyses. The analysis included only RFFAs with sufficient data for modeling.

Modeled cumulative impacts to air quality, air quality related values (visibility and deposition), and hazardous air pollutants were all below applicable thresholds with the exception of impacts to 24-hour $PM_{2.5}$ under Alternative C, which exceeded NAAQS and AAAQS near the North Operations Center.

Table 3.19.3. Past, Present, and Reasonably Foreseeable Future Actions Sources Considered for Air Quality Cumulative Impacts Assessment

Name of Facility	Miles from Willow Operations Center[a]	Included in Near-field Modeling	Included in Far-field Modeling	Source Type and Notes
TDX Deadhorse Power Plant	77	No	Yes	Modification to an existing source
ExxonMobil Point Thomson Facility Expansion	133	No	Yes	Modification to an existing source Project is already included in the BOEM Future Year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
Nanushuk Pad (proposed)	41	No	Yes	RFFA source
Nanushuk Drill Site 2 (proposed)	37	No	Yes	RFFA source
Nanushuk Drill Site 3 (proposed)	34	No	Yes	RFFA source
Nanushuk Operations Center (proposed)	41	No	Yes	RFFA source
Eni Nikaitchuq Development	60	No	Yes	RFFA source
Pioneer Oooguruk Development	47	No	Yes	RFFA source
BPXA Liberty	106	No	Yes	RFFA source Project is already included in the BOEM Future Year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
CPAI GMT-1	17	Yes	Yes	RFFA source Project is included in the BOEM Future Year database used in the Willow MDP EIS, so duplicate emissions were not added explicitly to the cumulative far-field modeling analysis.
CPAI GMT-2	11	Yes	Yes	RFFA source
Mustang Pad	44	No	Yes	RFFA source
Greater Willow Potential Drill Site #1	14	Yes	No	RFFA source Source not anticipated to be operational in 2025, the selected analysis year for the cumulative far-field modeling.
Greater Willow Potential Drill Site #2	8	Yes	No	RFFA source Source not anticipated to be operational in 2025, the selected analysis year for the cumulative far-field modeling.

Note: BOEM (Bureau of Ocean Energy Management); BPXA (BP Exploration Alaska); CPAI (ConocoPhillips Alaska, Inc.); EIS (environmental impact statement); GMT-1 (Greater Mooses Tooth 1); GMT-2 (Greater Mooses Tooth 2); RFFA (reasonably foreseeable future action)

[a] As measured for Alternative B.

3.19.6 Cumulative Impacts to Soils, Permafrost, and Gravel Resources

The effects of past and present actions have impacted soils and permafrost in the areas where ground-disturbing activities and gravel or ice infrastructure have occurred, as described in the affected environment in Section 3.4, *Soils, Permafrost, and Gravel Resources*. The Project would have effects like those of past and present actions and would contribute to the cumulative effects of past, present, and reasonably foreseeable future actions (RFFAs) on soils, permafrost, petroleum and gravel resources. Given the scope of the Project considered in context of past, present, and RFFAs, the Project would not change the cumulative impacts on soils, permafrost, or petroleum and gravel resources in the analysis area.

Global climate change is a current and reasonably foreseeable future condition affecting soils and permafrost in the analysis area. The depth of the active layer on the ACP within the NPR-A is projected to increase by 37% (an average increase from 1.32 to 1.81 feet across the ACP within the NPR-A) by the end of the century (SNAP 2011). The deepening of the active layer and degradation of the near-surface permafrost could lead to thermokarst development and alteration of ice-related geomorphological landforms from melting of the ground ice. The magnitude of disturbance and thermokarsting is directly related to the abundance of ground ice (USACE 2012). These effects would occur independent of the RFFA's effects on soils and permafrost.

3.19.7 Cumulative Impacts of Noise

The effects of past and present actions on noise have resulted in the affected environment conditions presented in Section 3.6, *Noise*. Noise from the Project would create noise in the analysis area and contribute to additive noise in areas where other RFFAs would also contribute noise at the same time. Almost all operational noise from the Project would attenuate to ambient sound levels prior to reaching Nuiqsut, and therefore would not affect the largest community in the analysis area. Cumulative operational and construction noise (and the Project's contribution to those cumulative effects) could affect subsistence activities by causing subsistence users to avoid areas impacted by noise (Section 3.19.11, *Cumulative Impacts to Subsistence and Sociocultural Systems*).

3.19.8 Cumulative Impacts to Visual Resources

The effects of past and present actions on visual quality have resulted in the affected environment as described in Section 3.7, *Visual Resources*. The RFFAs that would impact the same viewshed as the Project are primarily oil and gas related (Table 3.19.1). These RFFAs would include facilities and infrastructure that would have the same types of impacts to visual resources as described for the Project. These RFFAs would contribute cumulatively with the Project in creating strong to moderate contrasts in scenic quality Class C (low scenic quality) lands that are inventoried as VRI III. However, because they would occur in the seldom seen zone (greater than 15 miles distant), these RFFAs would not contribute cumulatively to impacts on scenic Class B (moderate quality) lands on the Colville River that are inventoried as VRI Class II.

3.19.9 Cumulative Impacts to Biological Resources

For the purposes of this cumulative effects analysis, biological resources are fish, marine mammals, birds, terrestrial mammals, and wetlands and vegetation. The impacts of past and present actions on biological resources are documented in Sections 3.9 through 3.13. In general, past and present actions across the ACP have impacted biological resources though short-term impacts (e.g., disturbance and displacement) and long-term alteration and loss of habitat. The Project would adversely impact wetlands and vegetation, as well as fish, marine mammals, terrestrial mammals, birds, and habitat for those animals. Implementation of BMPs and mitigation measures would lessen impacts to biological resources and the Project's contribution to cumulative impacts to biological resources.

As described in Section 3.9, *Wetlands and Vegetation*, disturbance and fill of wetlands in the analysis area has been primarily due to gravel and ice infrastructure development of the GMT and Alpine oilfields, the community of Nuiqsut, and decommissioned DEW Line sites. Existing infrastructure and activities have filled wetlands and altered some wetlands' functions, contribute dust and sediment to wetlands and vegetation, and increase the potential for spills to reach vegetation or wetlands. Though past and present actions have not introduced invasive plants into the analysis area, it is likely only a matter of time before existing populations of invasive species expand their range into NPR-A and the analysis area. Because humans are the primary dispersal mechanism for invasive species, RFFAs would likely contribute to factors that could expand the range of invasive species, mainly by building roads and expanding the range of human activity. If the gravel fill is not removed at the end of the Project, the abandoned pads and roads would support plants adapted to dryer habitats, including invasive species (such as dandelion and foxtail barley), should their range expand from current locations. These invasive species could be a seed source and impact adjacent habitats.

Reasonably foreseeable additional ice and gravel infrastructure would continue to impact wetlands and vegetation in similar ways as past and present development. The Project would impact wetlands and vegetation as described in Section 3.9 and would add to impacts of past, present, and RFFAs by removing and altering wetlands and disturbing vegetation. Some impacts would be permanent. The Project would likely fill no more than 0.2% of any of the watersheds in which it would occur, and vegetation impacts would likely affect no more than 1.2% of vegetation in any watershed. The Project would contribute to cumulative adverse impacts to wetlands and vegetation, but not significantly change those impacts.

As described in Section 3.10, *Fish*, fish would be impacted by construction activities that would potentially disturb, displace, injure or kill fish; remove, add, or alter fish habitat. The Project would contribute to cumulative effects of past, present and RFFAs on fish and fish habitat, but not significantly change the nature and magnitude of those impacts in the analysis area.

As described in Section 3.13, *Marine Mammals*, the Project may result in habitat loss and alteration, disturbance or displacement, or injury or mortality of marine mammals. Marine mammals would be cumulatively affected by RFFAs in the analysis area, and the Project would contribute to, but would not substantially change, those cumulative impacts.

As described in Sections 3.11, *Birds*, and 3.12, *Terrestrial Mammals*, the Project may result in habitat loss and alternation, disturbance or displacement, or injury or mortality of birds and terrestrial mammals. Some terrestrial mammals may also be impacted through attraction to human activities or facilities. Impacts to birds and terrestrial mammals would persist throughout construction and operations of the Project and would be lessened by BMPs. Birds and terrestrial mammals would be cumulatively affected by other RFFAs in the analysis area, and the Project would contribute to, but not substantially change, those cumulative effects.

Many of the RFFAs are in the range of the CAH, a herd that has been exposed to oil and gas infrastructure for approximately 40 years. The additional projects would result in additional disturbance and displacement during some seasons, but the potential demographics impacts from these projects would depend on the location and type of development. Murphy, Russell et al. (2000) found that changes in activity budgets of caribou from exposure to development were likely to have demographic impacts only at higher levels of exposure than currently exist. Nellemann and Cameron (1998) found that caribou density during calving declined with increasing road density. Colocating pipelines near existing infrastructure, avoiding development in calving areas, and using BMPs for development design would minimize impacts on caribou. Although the CAH has limited use of the Project area, the additional development would increase the total exposure to development for the herd.

The main RFFAs that could affect the TCH are the NPR-A IAP revisions, the Arctic Strategic Transportation and Resources (ASTAR) project, and future expansions of the Willow Project. Revisions to the BLM's NPR-A IAP that are currently underway may change the boundaries and stipulations associated with existing special areas, such as the TSLA. If areas are removed from special area designation, they would no longer have special protections for biological resources such as birds and caribou. The BLM is considering opening some of these lands near Teshekpuk Lake to leasing, if so, additional effects to the TCH and to birds could occur. If caribou are displaced from existing calving areas by future development, access to suitable alternative calving areas away from development would be required to minimize impacts, therefore the development of the Project area would result in less undeveloped area available for alternative calving areas. The relative value for calving habitat was mapped by Wilson et al. (2012).

The revisions to the NPR-A IAP could also allow 30 to 190 miles of new roads (and 30 to 190 miles of new pipelines), including a community road connecting Nuiqsut and Utqiagvik that would be routed north of Teshekpuk Lake. The ASTAR project could include additional road construction through seasonal ranges of the TCH and CAH. New roads could directly kill some caribou due to vehicle collisions, delay or alter caribou migratory movements (Panzacchi, Moorter et al. 2013; Wilson, Parrett et al. 2016), or increase access for local or non-local hunters. Changes to hunter access could impact all game species of birds and mammals although they could be mitigated through hunting regulations or road use limitations. Roads near calving areas would likely result in displacement of calving caribou unless they are closed during the calving season. Road construction north of Teshekpuk Lake could potentially interfere with the use of narrow corridors of land that are used to access mosquito-relief habitat (Yokel, Prichard et al. 2011). The addition of roads that could be used for hunting could alter the use of the Project roads by subsistence hunters.

Seismic activity associated with new oil and gas leasing could disturb wintering caribou of the TCH and other species wintering or denning on the ACP. Seismic trains and camps could cause some long-term damage to forage vegetation in some areas and cause snow compaction that could delay the timing of snowmelt and increase mortality and limit movements of small mammals. The impact of seismic activity on forage plants would be in addition to direct loss of forage from gravel roads and pads.

Climate change will continue to affect fish, birds, and wildlife throughout the area and could alter the rate or degree of potential cumulative impacts. Climate change, as described in Section 3.2, *Climate and Climate Change*, could have both positive and negative impacts on birds and terrestrial mammals Climate change may have been a factor in a 56% decline in populations of migratory caribou and wild reindeer across the Arctic over the last 2 decades (Russell, Gunn et al. 2019), and increases in the frequency or severity of rain-on-snow events could limit access to forage and change the winter distribution of the TCH (Bieniek, Bhatt et al. 2018), which could alter the use of the project area during winter in unpredictable ways.

Cumulative impacts on biological resources would contribute to impacts to subsistence, as described in Section 3.19.11, *Cumulative Impacts to Subsistence and Sociocultural Systems*.

3.19.10 Cumulative Impacts to the Social Environment (Land Use, Economics, and Public Health)

The effects of past and present actions on the social environment are presented in the affected environment section of Sections 3.14, 3.15, and 3.18. Since the 1970s, oil and gas development on the North Slope has substantially changed the social conditions, including economics, land use, and public health. The cumulative effects of past and present actions include formation of the regional Native corporation, village corporations, and municipal incorporations; employment in the oil and gas industry, supporting sectors, and government; and provision of health care services. These changes have, in turn, resulted in other changes that have both increased sociocultural stressors and provided improved health care. The Project's sociocultural and economic effects would occur throughout the analysis area but would be more substantial in Nuiqsut due to the proximity to Project activities and subsistence use of the area. The Project would add jobs for construction, operations, and supporting services; most direct wages from new employment generated by the Project would go to nonresidents of the NSB, but some new wages would accrue in both the local and regional economy.

The Project would have similar impacts to the social environment as past and present oil and gas development projects have had and would contribute to, but not substantially change, the cumulative social impacts of past, present and RFFAs.

3.19.11 Cumulative Impacts to Subsistence and Sociocultural Systems

The effects of past and present actions on subsistence and sociocultural systems are described in Section 3.16, *Subsistence and Sociocultural Systems*. Past and present actions have cumulatively impacted subsistence activities and sociocultural systems in the analysis area. As noted in Section 3.16 regarding the subsistence use areas for Nuiqsut:

> Impacts [of oil and gas development] include disruption of subsistence activities from increased air and ground traffic; decreased access to traditional use areas resulting from security restrictions and increased infrastructure (e.g., pipelines, roads, and pads); reduced availability of subsistence resources due to disruption from oil and gas activity and infrastructure; avoidance of subsistence foods due to contamination concerns; and avoidance of traditional use areas due to discomfort about hunting around industrial development (SRB&A 2009, 2017b, 2018a). Throughout the 9 years of the Nuiqsut Caribou Subsistence Monitoring Project, the percentage of harvesters reporting one or more impacts during individual study years has ranged from 27% (in Year 9) to 72% (in Year 1). While impacts related to helicopter traffic have decreased in recent years, impacts related to human-made structures have increased slightly, likely related to increased road infrastructure in the area (SRB&A 2018a). In addition, between 33% and 46% of harvesters reported they avoid developed areas during individual study years (CPAI 2018b).

Changes in subsistence resource availability, harvester access, and ability to participate in subsistence activities have also affected sociocultural systems as Iñupiat social organization, cultural values, social ties, and community and individual well-being are inextricably linked with subsistence. Additional changes associated with modernization, the transition from a subsistence economy to a mixed subsistence-cash economy, formation of Native and village corporations and municipal governments, and increasing interaction with non-Iñupiat individuals have affected sociocultural systems in the study communities.

Human activity, ground and air traffic, noise, and infrastructure have the potential to affect the availability of subsistence resources in the analysis area by disturbing or displacing subsistence resources or making them more difficult to harvest. The Project could affect the availability of caribou to Nuiqsut and Utqiaġvik subsistence users, although a majority of direct and indirect impacts to resource availability would occur for Nuiqsut as most Utqiaġvik caribou harvesting areas occur to the west of the Project. The analysis area has provided up to 19% of the total caribou harvest during some years, and harvests are even more concentrated directly east of the Willow area. Thus, impacts on caribou availability within the area west of Nuiqsut could have substantial impacts to subsistence users. The Project would impact availability of other subsistence resources such as furbearers, waterfowl, and fish. The Project overlaps with Utqiaġvik furbearer harvesting areas and could affect the availability of wolf and wolverine to Utqiaġvik subsistence users. Access to subsistence harvest areas could be physically restricted during construction, particularly for Nuiqsut; however new gravel roads would increase harvester access for those who choose to use Project roads. Regardless of physical access, some harvesters may avoid construction and operations areas due to discomfort hunting and shooting near industrial infrastructure; lack of knowledge about security protocols; concerns about resource contamination; and an assumed lack of resource availability near infrastructure. During operations, harvester avoidance of the Project area may be reduced from construction levels due to decreased noise and traffic disturbances, although avoidance responses would likely continue throughout the life of the Project for certain individuals.

Social and economic effects of the Project could impact subsistence through subsistence/work conflicts (for residents who have jobs related to the Project), and a shift in subsistence roles could affect social ties in the community.

Reasonably foreseeable future oil and gas activities (i.e., most of the RFFAs considered in the analysis, Table 3.19.1) would have similar impacts to subsistence as the Project and may occur within the analysis area. Non-oil and gas activities could also occur and would have lesser impacts than the Project. The Project's impacts on subsistence would be additive to the impacts of activities of past, present, and RFFAs that have cumulatively affected the analysis area. The Project would increase those cumulative effects and would amplify effects to subsistence resource availability such that impacts to other North Slope communities such as Anaktuvuk Pass and Atqasuk would be more substantial.

Revisions to BLM's NPR-A IAP that are currently underway may change the boundaries of existing special areas, such as the TSLA. If areas are removed from special area designation, they would no longer have special protections for biological resources such as birds and caribou, which are also subsistence resources. BLM is considering opening some of these lands near Teshekpuk Lake to leasing, if so, additional decreases in subsistence resource availability and abundance (namely for caribou and birds, though all resources could be affected), and increases in subsistence access could occur.

Effects of the Project in combination with RFFAs such as the NPR-A IAP revisions (i.e., changes in the boundaries of the TSLA, construction of a road connecting Nuiqsut and Utqiaġvik, and seismic activity associated with new oil and gas leasing) could result in increased likelihood of changes to resource availability for Nuiqsut and Utqiagvik as well as other North Slope communities. In particular, if caribou are displaced from current calving areas resulting from additional oil and gas development, or if new roads in the area result in delays or alterations of TCH migratory movements, then residents of communities who harvest from the TCH, including Anaktuvuk Pass and Atqasuk, could experience reduced availability of caribou.

Table 3.19.4 summarizes cumulative effects to subsistence uses for Nuiqsut and Utqiaġvik.

Table 3.19.4. Comparison of Impacts to Subsistence Uses for Nuiqsut and Utqiaġvik

Effects To	Nuiqsut	Utqiaġvik
Resources (Importance)	Caribou (Major) Furbearers (Minor)[a] Waterfowl (Major) Fish (Major) Seals (Major)	Caribou (Major) Furbearers (Minor)[a]
Resource Abundance	Possible impacts to TCH herd abundance resulting from displacement from core calving grounds.	Possible impacts to TCH herd abundance resulting from displacement from core calving grounds.
Resource Availability	For all resources, high likelihood of reduced resource availability resulting from increased impacts from infrastructure, noise, and traffic.	For all resources, high likelihood of reduced resource availability resulting from increased impacts from infrastructure, noise, and traffic occurring within Utqiagvik subsistence use areas.
Harvester Access	High likelihood of increased physical and legal barriers to access to traditional subsistence use areas.	Low to moderate likelihood of increased physical and legal barriers to access to traditional subsistence use areas.

Note: TCH (Teshekpuk Caribou Herd)
[a] Despite being characterized as a resource of minor importance based on selected measures, furbearer hunting and trapping is a specialized activity with unique importance to the study communities.

3.19.12Cumulative Impacts to Environmental Justice

The area around Nuiqsut has experienced a substantial increase in oil and gas exploration and development over the past few decades. Past developments have positively and negatively affected the community. Positive effects include increase wages, a higher standard of living and improved access to healthcare. Increased revenue from development for NSB and ASRC has also positively impacted Nuiqsut residents through health and social programs funded by these organizations, more job opportunities associated with programs run by these organizations, and increased dividends for ASRC shareholders.

However, these changes have also given rise to several negative social and public issues. Negative effects of past and current development activities include changes in subsistence resource availability, increased concerns about the potential for health impacts from North Slope development (particularly air emissions and the potential for spills and contamination), and increased income disparities in Nuiqsut between ANCSA corporation shareholders and non-shareholders. It is expected these effects would continue to grow as development increases in the area.

Climate change is also affecting Nuiqsut residents and is likely to affect the community more in the future. As temperatures increase, snow and ice cover are expected to decrease, and vegetation and habitats may change. These changes can affect human health and safety by making travel conditions more unpredictable or by affecting habitat availability, quality and suitability for Nuiqsut subsistence resources, in particular caribou. These changes would likely create additional stress to Nuiqsut residents with the current, proposed, and reasonably foreseeable development in their subsistence use areas. Climate change effects to the North Slope are, however, experienced by all NSB residents and are not expected to be generally disproportionate for Nuiqsut residents.

It is anticipated cumulative effects to Nuiqsut would continue to be both positive and negative in the foreseeable future. The cumulative effect overall is not anticipated to be high and adverse, except for the effects to subsistence caribou harvests.

3.19.13 Conclusions

Cumulative effects of past, present, and RFFAs have impacted the natural and human environment. The Project would have impacts that are additive to those effects but would not substantially change the overall effects. As described above and in Section 3.2, global climate change will continue to affect the natural and human environment. These effects would be additive to and synergistic with the cumulative effects of the Project and past, present, and RFFAs.

4.0 SPILL RISK ASSESSMENT

This chapter provides a qualitative assessment of potential spills and addresses the types of spills that may occur and their likely occurrence, potential size (volume), duration, and geographic extent based on historical data and the Project's design features. These would vary by Project phase and are discussed by phase in the results. Appendix H, *Spill Summary, Prevention, and Response Planning*, describes preventive measures and response planning activities CPAI would implement to minimize potential damage to human health and the environment from oil spills or other accidental releases.

The history of oil spills on the North Slope (e.g., location, type, volume) has been evaluated and analyzed in several recent technical studies and EIS, including BLM (BLM 1998, 2004a, 2012b, 2014a), USACE (2012, 2018), BOEM (2013), and ADEC (2010, 2013). The ADEC Spills Database (2019b) reported more recent data: seven crude oil spills ranging in volume from less than a gallon up to 50 gallons, and seven process water spills ranging in volume from 200 and 1,263 gallons have occurred since publication of USACE (2018). None of these spills are unique or change the results or conclusions presented in this analysis.

The Spill Risk Assessment (SRA) uses the historical data and analysis of oil spills on the North Slope (including NPR-A) to qualitatively evaluate the Project's potential for oil spills. Although Chapter 2.0, *Alternatives*, presents a range of alternatives for the Project, the number of wells, their location, and overall planned production rates (i.e., volumes) are similar for all action alternatives; consequently, the results of this SRA would be the same for all action alternatives. Potential impacts from spills on specific resources are discussed in Chapter 3.0, *Affected Environment and Environmental Consequences*.

As part of the permitting process with the State, CPAI would be required to provide more detail regarding potential spills, design features and measures to prevent spills, and its spill response and planning measures as part of the Project's ODPCP.

4.1 Spill Risk Assessment Approach

4.1.1 Types of Spills

The types of spills identified in the SRA considered the types of activities that would occur by Project phase and the machinery and fuels associated with them. During construction, potential spill locations could include marine waterways, ice and gravel infrastructure, and the Tiŋmiaqsiuġvik mine site. During drilling and operations, potential spill locations could include gravel pads, as well as tundra and waterbodies adjacent to or crossed by pipelines. The type of fluids evaluated in this SRA include produced fluids taken directly from the well and composed primarily of crude oil, water, natural gas, gas condensates (if present), and formation sand; processed sales-quality crude oil; refined products such as diesel and gasoline; produced water; and seawater. Section 4.4, *Hazardous Materials*, addresses the potential occurrence of hazardous material spills.

4.1.2 Spill Likelihood and Size

The likelihood or the expected relative rate of spill occurrence during all phases of the Project is described in six categories: very high, high, medium, low, very low, and would not occur. Spill size categories and their associated volumes are provided in Table 4.1.1.

Table 4.1.1. Spill Size Categories and Spill Volume Ranges

Spill Size Category	Spill Volume (gallons)	Spill Volume (barrels)
Very small	<10	<0.24
Small	10 to 99.9	0.24 to 2.4
Medium	100 to 999.9	2.4 to 24
Medium-large	1,000 to 9,999.9	24 to 240
Large	10,000 to 100,000	240 to 2,400
Very large	Over 100,000	Over 2,400

These values adequately define the range of historical spill volumes and are similar to the values used in past assessments and studies of oil spill risk for this region. The above spill size classifications are similar to those used by ADEC when it responds to and evaluates oil spills and are consistent with those used in its 2013 North Slope spill analysis (ADEC 2013).

4.1.3 Duration

Durations noted in the risk assessment describe the duration of the potential release; the duration of the spill response or potential impacts of the release on resources could be much longer.

4.1.4 Geographic Extent

The geographic extent of potential spills considers the spill's location, size, and estimated duration, and assumes spill response actions would be consistent with the requirements outlined in CPAI's spill response plans that would be developed and approved for the Project. The analysis assumed typical environmental conditions during the spill event; if a spill occurred during atypical environmental conditions (e.g., periods of high flows or flooding), the geographic extent could be much larger.

4.2 Potential Spills During Construction

Most spills to the marine environment would be expected to be very small to small, limited to refined products (e.g., diesel, lubricating oil), localized to the immediate area of the sealift module transfer location, and short in duration (less than 4 hours). The expected spill occurrence rates for these spill types would be low to very low and the spills would be expected to occur during construction of the module delivery site itself or originate from smaller watercraft (e.g., tugs that handle the module delivery barges, support vessels). It would be possible, although of very low likelihood, that a medium to very large spill could occur along existing marine waterways leading to the sealift module transfer site. This would only occur if a tug or barge transporting modules runs aground, sinks, or its containment compartment(s) were breached and the contents released (USACE 2012). The duration of these spill types would vary from about a day to up to several days, depending on the spill's location and the proximity of the shore-based response. Similarly, the geographic extent of these spills would vary and may or may not reach land, depending upon the location of the spill and prevailing meteorological and oceanographic conditions at the time of the spill. Since the duration and frequency of marine vessel use for the Project would be limited, the likelihood of a spill of this nature would be very low.

Spills occurring on ice and gravel roads could result from construction vehicles capable of hauling gravel, bulk fuels, equipment, and other supplies. The likelihood of occurrence for very small to small spills of fuel or refined products is medium to low, and spills could occur in the event of vehicle accidents. Spills of this nature would happen at the time of the accident, last less than an hour, and be limited to the road or to tundra immediately adjacent to the road. It is expected that these spills would be quickly contained in the immediate area of the spill and would not move far from the accident site to tundra or other sensitive habitats. The likelihood of occurrence for medium to medium-large spills of diesel or other refined product is very low, but spills could occur if a large truck accident resulted in the breaching of its fuel tanks. Spills of this nature would also occur at the time of the accident, last less than an hour, and be limited to the road and area immediately adjacent to the road. It is possible this type of spill could reach small areas of tundra or waterbodies immediately adjacent to roads.

The volume of potential spills from a large bulk-fuel tanker truck accident could range from very small to large. A large spill could occur if the entire capacity of the truck's bulk-fuel tank emptied. Spills of this nature would be expected to be of short duration (less than 0.5 day). The likelihood of an event of this nature occurring is considered medium for very small to small spills, low for medium size spills, and low to very low for medium-large and large spills because large tanker trucks consist of multiple smaller, segregated tanks, and it is very unlikely that all tanks would be ruptured in a single accident. In the event of a large spill, the geographic extent would likely include roads and adjacent roadside habitats and possibly waterbodies. The geographic extent of a spill of this size would vary depending on the season; however, the spill would be localized and likely affect an area up to 0.5 acre in size. Very large spills would not be expected to occur from bulk-fuel tanker truck accidents.

Spills occurring on ice or gravel pads could occur at vehicle and equipment storage areas, equipment maintenance and repair facilities, designated refueling areas, and at temporary aboveground storage tank (AST) locations. These spills could involve a variety of refined products such as diesel, gasoline, hydraulic fluid, lubricating oil, grease, waste oil, mineral oil, and other products. Spills could occur on gravel pads, inside buildings, or inside secondary containment areas. The likelihood of very small to small spills occurring is very high to high; the likelihood of medium to large spills is medium to high. On-pad spills of all sizes would be of short duration (less than 0.5 day) and would remain on the pad or within secondary containment; damage to areas adjacent to pads would not be anticipated. Very large spills of refined products along ice or gravel pads would not be expected to occur during construction.

4.3 Potential Spills During Drilling and Operations

Spills could occur as a result of blowouts during well drilling activities. A blowout (the uncontrolled release of produced fluids or natural gas or both) after pressure control systems have failed can occur when shallow, high-pressure gas deposits are unexpectedly encountered beneath the surface and above the target oil reservoir depth (**shallow-gas blowout**) or when target oil reservoir pressures are much higher than anticipated and planned for (reservoir blowout or **well blowout**).

Only seven shallow-gas blowouts have occurred on the North Slope since 1974. Although it is conceivable that a shallow-gas blowout could occur during drilling, the expected relative rate of occurrence of such an event would be very low. In the event one did occur, it would likely have a duration of 1 to 2 days and affect approximately 20 to 25 acres of tundra adjacent to the well pad (USACE 2018). Spilled material would include drilling fluids (i.e., mud), but not crude oil.

There have been no reservoir blowouts on the North Slope since drilling began in the late 1960s (approximately 7,000 wells). The expected rate of occurrence for a reservoir blowout to occur as part of the Project would be very low (approaching zero). For response planning purposes, CPAI calculated potential discharge from a reservoir blowout from any drill pad during drilling (in accordance with 18 AAC 75.434(e)) that resulted in a spill volume of 15,000 barrels per day for 15 days (225,000 barrels [9.5 million gallons] total release) (CPAI 2019b). The modeling results suggest that up to 10% of the discharged oil would remain airborne as an aerosol and 90% would be expected to reach the ground surface downwind of the well based on typical prevailing wind patterns at the time of the spill. Figures 4.3.1 through 4.3.5 illustrate the modeled reservoir blowout scenario at drill sites BT1 through BT5 under winter and summer conditions. Table 4.3.1 summarizes the approximate extent and volume of oil to reach the ground surface in the event of a reservoir blowout.

Table 4.3.1. Approximate Distance and Width of Oil Fallout from a Reservoir Blowout, Based on Percent Discharged

Spill Volume in Barrels (percent of total spill volume)	Distance from Wellhead (feet)	Width of Fallout (feet)
22,500 (10)	213	52
45,000 (20)	223	56
67,500 (30)	282	62
90,000 (40)	361	75
112,500 (50)	492	92
135,000 (60)	623	121
157,000 (70)	1,115	197
180,000 (80)	3,117	574
202,500 (90)	22,310	2,953

Source: CPAI 2019a
Note: Spill volume based on total reservoir blowout of 225,000 barrels.

The radii in Figures 4.3.1 through 4.3.5 demonstrate the 70%, 80%, and 90% extent limits for oil fallout (i.e., oil that would reach the ground) in this scenario; the oil plume trajectories represent prevailing wind conditions and indicate the most likely areas to be impacted in the event of a reservoir blowout. Approximately 10% of the discharged oil would be in aerosol in droplets so small (50 micrometers or less) that they would not reach the ground. If a reservoir blowout were to occur, there is potential for oil to reach nearby freshwater lakes and stream channels; however, a reservoir blowout is unlikely to reach Harrison Bay due to its distance from the drill sites and the sinuous nature of area streams. BT4 is approximately 17.5 river miles from Harrison Bay (via the Kalikpik River) and the other drill sites are at least 50 river miles or more from Harrison Bay (via the Fish (Iqalliqpik) Creek basin). Because the streams are all highly sinuous, flow would be slower than less sinuous streams, and there would be more shoreline on which the oil could strand and potentially be recovered.

Spills on gravel pads directly associated with petroleum development infrastructure could originate from wellheads (leaks from the wellhead or the well casing during normal operations), facility and process piping, or from ASTs. Based on historical spills data, the expected rate of occurrence of wellhead spills would be very low to low; they would range in size from very small to large, typically last from a few hours to a few days, and be contained within the immediate vicinity of the well itself and not be expected to reach areas beyond the gravel pad.

Facility piping includes pipelines that run from individual wells to pipeline manifolds that then connect to produced fluids pipelines (i.e., infield flowlines) and on-pad piping that connect ASTs to on-pad equipment (e.g., drilling rigs, generators). Process piping includes pipes inside pipeline manifold buildings and crude-oil processing modules. Based on historical North Slope spills data, the expected occurrence rate for these spills would range from very high for very small spills to very low for very large spills. The expected duration of these spills could range from very short (less than 4 hours) for very small spills to a few days for large spills; these spills would be expected to be contained inside buildings or on gravel pads.

Based on ADEC data (ADEC 2010, 2013), ASTs associated with petroleum development infrastructure have the second lowest frequency of loss of integrity spills: only 10 spill cases were recorded from July 1995 through 2011, an average of about 0.6 spills per year. There is no indication that any of these spills escaped secondary containment. For this reason, the expected frequency of spill occurrences from ASTs from the Project is expected to be very low to low. Spill volumes from ASTs would be dependent on the size and location of the leak (on the tank) and the overall capacity of the tank itself. Leaks from a large AST would likely be noticed within a day of the leak forming but securing the leak could take a few days depending on the leak's location on the tank. Spilled material from an AST would be captured within secondary containment. In the unlikely event that a spill escaped secondary containment, it is expected the spill would be limited to the gravel pad where the tank is located. Modeling conducted for CPAI's ODPCP for Alpine facilities (CPAI 2018c) suggests that if a complete failure of a 3,300-barrel diesel tank occurred, 60% (1,980 barrels) would remain within secondary containment and 40% (1,320 barrels) would reach the gravel pad without affecting adjacent tundra areas. Similar results would be expected from the Project.

Pipeline spills could occur along infield pipelines that transport produced fluids (composed of oil, water, and natural gas, with a general split of 70% oil and 30% water gas mixture) from drill pads to processing facilities. Leaks from produced fluids pipelines could result in spills sizes ranging from very small spills to medium-large spills. The expected duration of these types of spills could be very short (less than 4 hours) or continue for a period of days to weeks depending on the type and location of the leak. The expected occurrence rate of these spills would be very low to low (BOEM 2013). Very small spills would be expected to be contained within a small area in the immediate vicinity of the spill; however, large spills that go undetected for a period of time could affect an area a few acres in size before the spill is contained. Estimated discharges from guillotine ruptures of produced fluids pipelines for all crossings of Willow Creek 8, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek are shown in Table 4.3.2 (also Figures 2.4.1 through 2.4.3 in Chapter 2.0, *Alternatives*). There have been no documented cases of guillotine failures occurring on the North Slope, mainly because the conditions most likely to cause this type of failure are not present in the region (e.g., active geological faults, landslide-prone topography). The spill's location and time of year would also influence the spill area extent, with larger spill volumes potentially affecting creek and creek shoreline habitat several miles downstream from the leak source. A spill from a pipeline crossing of streams in the Project area could reach the channels of Fish (Uvlutuuq) Creek or the Kalikpik River, particularly during periods of flooding. The relatively low flow and highly sinuous nature of streams in the area may preclude a spill into one of these rivers from reaching Harrison Bay.

Table 4.3.2. Produced Fluids Pipeline Estimated Spill Volume at Select Waterway Crossings

Pipeline Section	Section Length (feet)	Total Spilled Volume (gallons)	Volume of Oil Spilled (gallons) (70% of total)[a]	Volume of Oil Spilled (barrels) (70% of total)[a]
Willow Creek 8[b]	34,320	522,520	365,764	8,709
Fish (Uvlutuuq) Creek[c]	2,514	41,681	29,177	695
Judy (Kayyaaq) Creek[b]	75	8,484	5,939	141
Judy (Iqalliqpik) Creek[c]	4,413	77,740	54,418	1,296

Source: CPAI 2019a

Note: Volume spilled is based on crude oil pipeline discharge calculations presented in 18 AAC 75.436 and 49 CFR 194.105(b)(1), where the discharge volume equals the capacity of the pipeline section plus the potential volume of oil discharged during time to detect and time to shutdown (5 minutes to detect and 1 minute to shutdown were used in this table), multiplied by the flow rate based on 21,000 barrels per day from each drill pad.

[a] Produced fluids are composed of oil, water, and natural gas, with a general mixture ratio of 70% oil and 30% water/gas.

[b] Capacity of pipeline at stream crossing based on hydraulic characteristics of the pipeline due to terrain profile change at bridge (i.e., elevation rise), which would limit spill volume to that contained in the section of pipeline along bridges.

[c] Capacity of pipeline at stream crossing based on the volume of the section of pipeline between automated valves.

The Willow Pipeline (export) would transport sales-quality crude oil from the WPF to Kuparuk CPF2. Leaks that could occur along the export pipeline would be expected to result in spills ranging in size from very small spills to very large spills. The duration of these types of spills could be very short (less than 1 hour) or continue for a period of days to weeks depending on the size and location of the leak along the pipeline corridor. The expected rate of occurrence of spills from the Willow Pipeline would be very low. Very small spills would be expected to affect a small area in the immediate vicinity of the spill; however, larger spills that go undetected for an extended period could affect an area several acres in size before the leak is stopped. The overall area affected by spills would also be influenced by the location and time of year the spill occurred.

Leaks that could occur along the diesel pipeline would be expected to result in spills ranging in size from very small to medium; medium-large to very large spills would not be expected to occur along the diesel pipeline. The duration of these types of spills could be very short (less than 1 hour) or continue for a period of days to weeks depending on the size and location of the leak along the pipeline corridor. The expected rate of occurrence of spills from the diesel pipeline would be very low. Very small spills would be expected to affect a small area in the immediate vicinity of the spill; however, larger spills that go undetected for an extended period could affect an area of several acres before the leak is stopped. The area affected by spills would also be influenced by the location and time of year the spill occurred. An estimated 2 barrels (84 gallons) of diesel could be spilled in a guillotine rupture of the diesel pipeline where it crosses Judy (Kayyaaq) Creek (Alternative C; Figure 2.4.2).

Estimated discharges from potential guillotine ruptures of produced water injection pipelines for all crossings of Willow Creek 8, Judy (Kayyaaq) Creek, Judy (Iqalliqpik) Creek, and Fish (Uvlutuuq) Creek (Figures 2.4.1 through 2.4.3) are shown in Table 4.3.3. Produced water is composed of water and residual crude oil, the ratio of which varies over the life of the field; for planning purposes, a ratio of 5% oil and 95% water is used. The location and time of year of the spill would also influence the spill area extent, with larger spill volumes potentially affecting creek and creek shoreline habitat several miles downstream of the leak. The effects of produced water spills on tundra or waterbodies are addressed in appropriate resource sections in Chapter 3.0, *Affected Environment and Environmental Consequences*.

Table 4.3.3. Produced Water Injection Pipeline Estimated Spill Volumes at Select Waterway Crossings

Pipeline Section	Section Length (feet)	Total Spilled Volume (gallons)	Volume of Oil Spilled (gallons) (5% of total)[a]	Volume of Oil Spilled (barrels) (5% of total)[a]
Willow Creek 8	35,376	127,512	6,376	152
Fish (Uvlutuuq) Creek	1,100	7,865	393	9
Judy (Kayyaaq) Creek	75	8,312	416	10
Judy (Iqalliqpik) Creek	420	13,541	677	16

Source: CPAI 2019a

Note: Volume spilled is based on crude oil pipeline discharge calculations presented in 18 AAC 75.436 and 49 CFR 194.105(b)(1), where the discharge volume equals the capacity of the pipeline section plus the potential volume of oil discharged during time to detect and time to shutdown (5 minutes to detect and 1 minute to shutdown were used in this table), multiplied by the flow rate based on 23,000 barrels per day from each drill pad. Automated valves are not planned on produced water injection pipelines. Capacity of pipeline at stream crossing based on hydraulic characteristics of the pipeline due to terrain profile change at bridge (i.e., elevation rise), which would limit spill volume to that contained in the section of pipeline along bridges. Where crossings may not be bridges (Willow Creek 8) hydraulic characteristics are considered zero.

[a] Produced water is composed of water and residual crude oil and has a variable ratio of oil to water over the life of the field; for planning purposes, a ratio of 5% oil and 95% water is used.

Pinhole leaks could occur in seawater lines and would be expected to result in spills ranging in size from very small to large depending on the time it would take to detect the spill and secure the leak. Leaks could occur on gravel pads or tundra and waterbodies between pads or both. The effects of seawater spills on tundra or waterbodies are addressed in appropriate resource sections in Chapter 3.0.

During drilling and operations, spills that are not specifically associated with petroleum development infrastructure (as discussed above) could also occur. These spills include those associated with warehouse and storage facilities, equipment maintenance and repair activities, as well as vehicle and equipment refueling activities. These spills would involve a variety of refined products such as diesel, gasoline, hydraulic fluid, lubricating oil, grease, waste oil, mineral oil, and other products. Spills would occur on gravel pads, inside buildings, or inside secondary containment areas. The likelihood of very small to medium spills is high to very high. On-pad spills of this nature would be detected and responded to quickly, be of short duration (less than 0.5 day) and would remain on the pad or within secondary containment; damage to areas adjacent to pads would not be anticipated.

Spills along roadways associated with accidents involving vehicles transporting personnel, equipment, and supplies could also occur during drilling and operations. It is expected that spill events associated with vehicle accidents would similar to those previously described and discussed above in Section 4.2, *Potential Spills During Construction.*

4.4 Hazardous Materials

In addition to the potential for spills of oil, associated produced water, or seawater to occur, a number of hazardous materials would also be used by the Project. These include, but are not limited to, the use of corrosion inhibitors, methanol, antifreeze, other glycols, acids, lube oils, used oil, and hydraulic fluids. These materials would be predominately used during drilling and operations, and are typically stored inside buildings, or in aboveground storage tanks with necessary secondary containment, both of which are located on gravel pads.

Using the ADEC spill database, USACE (2012) identified a total of 9,106 spills that occurred on the North Slope between 1995 and 2009. The spills of commonly used hazardous materials for typical oil drilling and production activities are summarized in Table 4.4.1. The ADEC database also contains data from 2009 to 2019; however, information such as those summarized in Table 4.4.1 (e.g., largest spill, total volume spilled, and average volume spilled, and spill type) are not readily extractable, thus USACE (2012) was used as the best summary and source of useable data.

Table 4.4.1. Summary of Selected Hazardous Material Spills on the North Slope, 1995–2009

Hazardous Material	Number of Spill Records	Average Number of Records	Largest Spill (gallons)	Total Volume Spilled (gallons)	Average Volume Spilled (gallons)	Percent of All Spill Records[a]
Hydraulic oil	1,727	115.1	660	23,353	13.5	19.2
Methanol	532	35.5	12,811	57,682	108.4	5.9
Corrosion inhibitors	520	34.7	500	6,999	13.4	5.8
Engine lube oils	519	34.6	650	8,590	16.6	5.8
Antifreeze (ethylene glycol)	443	29.5	5,700	29,182	65.9	4.9
Other glycols	245	16.3	4,074	18,582	75.8	2.7
Acids	148	9.8	211	7,848	53.0	1.6
Used oil	38	2.5	2,020	4,755	125.1	0.4

Source: USACE 2012.
Note: USACE (2012) uses data from the ADEC Spills Database.
[a] Percent of 9,106 total spill records.

As shown in Table 4.4.1, average volumes for hazardous materials spills range from small to medium; though some spills were medium large to large. Based on this historical data, the likelihood of a hazardous material spill occurring from the Project is very high. However, the duration of potential hazardous materials spills is expected to be short (typically less than 4 hours), and identified and responded to quickly, as consistent with required spill plans (SPCC Plan, ODPCP, and Facility Response Plan). It is expected that hazardous material spills would be localized and contained within required secondary containment or contained in the immediate area of the spill on the gravel pad. Hazardous materials spills are not expected to extend beyond gravel or ice infrastructure.

4.5 Summary

Any North Slope oil and gas development, including the Project, would likely incur spills despite continued improvements in engineering design; a greater emphasis on clean and safe operations; adherence to the use of BMPs; continued improvements in, and awareness of, spill prevention; and improvements in spill response capabilities. Very small to large spills of refined oils could occur during construction; however, these accidental releases would occur on gravel or ice infrastructure, or into secondary containment structures. These types of spills occurring on gravel or ice infrastructure would be expected to have very limited to no impact to tundra or waterbodies adjacent to these facilities.

Spills along roadways would be limited to the road or tundra immediately adjacent to the road. It is expected that these spills would be quickly contained in the immediate area of the spill and would not move far from the accident site. If a spill occurred from a large bulk-fuel tanker truck accident and the tanker volume was released, the geographic extent would likely include the road and the area adjacent to the road , including waterbodies. The geographic extent of a spill of this size would vary depending on the location of the accident and the season in which it occurred; however, the spill would be localized and most likely affect an area up to 0.5 acre in size.

Very small to spills of refined products to the marine environment could during construction of the MTI or originate from smaller watercraft (e.g., tugs, support vessels, etc.). It would be possible, although of very low likelihood, that a medium to very large spill could occur along the barge or support vessel route in marine waters leading to the MTI site.

During drilling and operations, very small to medium spills may occur. Accidental releases could also occur from leaking wellheads, facility piping, or process piping. Spills of this type would be expected to be contained to and cleaned up on gravel pads and would not be expected to result in damage to adjacent tundra or waterbodies. Spills that originate along produced fluids pipelines or the export/import pipelines (e.g., sales-quality crude oil, seawater, diesel) would be expected to be detected and responded to quickly and would have a limited geographic extent. In the very unlikely event of a large or very large pipeline spill occurring at creek crossings, or during periods of high flow, the extent of the accidental release could be much larger. Table H.1.1 in Appendix H, *Spill Summary, Prevention, and Response Planning,* provides a summary of spill types, volumes, likelihood, duration, and estimated geographic extent for the action alternatives. Appendix H also describes numerous oil spill prevention and response planning measures that CPAI would implement. The results of this SRA (including Appendix H) suggest that the Project would not present a uniquely or an unusually high likelihood of a large or very large spill event occurring from petroleum development infrastructure. It would have similar likelihood of spills as other petroleum development infrastructure on the North Slope.

4.1.5 Comparison of Action Alternatives

All action alternatives would have similar likelihood of a spill occurring, and similar pipeline routes and waterbody crossings. Although the number and location of drill sites; the number of wells; and the hydrocarbon pipeline diameters, operating pressures, and throughput capacities are the same for each action alternative, there are several subtle differences in hydrocarbon pipelines among the alternatives that could influence the potential impacts and risks posed by a potential oil spill or other accidental release. These characteristics include total pipeline length and distance from roads, which expresses the difficulty of detecting (visual monitoring) and responding to a potential spill. Table 4.5.1 summarizes the pipeline differences among action alternatives.

As shown, Alternative B would truck diesel 37.5 miles from Alpine CD1 to the WPF, while the other two action alternatives would not truck diesel but would have a diesel pipeline along the entire corridor. Because the likelihood of spills from trucking diesel is higher (very low to medium) than the likelihood of spills from a diesel pipeline (very low), Alternative B would have a higher potential for diesel spills.

Table 4.5.1. Summary of Pipeline Differences Among Action Alternatives

Characteristic	Alternative B: Proponent's Project	Alternative C: Disconnected Infield Road	Alternative D: Disconnected Access Road
Diesel Pipeline Route	Kuparuk CPF2 to Alpine CD1	Kuparuk CPF2 to Alpine CD1 to South WOC to North WOC	Kuparuk CPF2 to Alpine CD1 to WOC
Diesel Pipeline Length (Miles)	34.0	80.5	72.8
Miles diesel would be trucked by road	37.5 to WPF	0	0
Miles of pipeline without a parallel road	0	3.9	9.8

Note: WOC (Willow operations center)

5.0 AVOIDANCE, MINIMIZATION, AND MITIGATION

5.1 Introduction

NEPA regulations (40 CFR 1508.20) define mitigation as avoiding, minimizing, rectifying, reducing over time, or compensating for impacts of a proposed action. For actions on federally managed land in the NPR-A, the BLM has developed a series of protective measures to mitigate potential impacts. These are defined and evaluated in the NPR-A IAP/EIS (BLM 2012b) and adopted in the ROD (BLM 2013a). State regulatory standards and permits also have requirements designed to protect environmental health and serve to mitigate impacts from development; however, the BLM does not have the authority to enforce or modify these regulatory requirements.

This chapter summarizes the proposed mitigation measures, including a general description of avoidance and minimization measures incorporated into the design, LSs, and BMPs (existing and proposed), and compensatory mitigation. Each resource section in Chapter 3.0, *Affected Environment and Environmental Consequences*, describes the specific mitigation measures and BMPs that would reduce impacts to that resource in additional detail.

5.2 Impact Mitigation

5.2.1 Bureau of Land Management Existing Lease Stipulations and Best Management Practices

The 2013 NPR-A IAP/EIS ROD includes a number of protective measures that would be imposed on activities permitted by the BLM in the NPR-A (BLM 2013a). These protective measures are in the form of LSs and BMPs, as summarized in Table I.1.1 in Appendix I.1, *Avoidance, Minimization, and Mitigation*. Lease stipulations are specific to oil and gas leases and describe objectives for protection of certain resources and management of certain activities. Best management practices apply to all activities in the NPR-A. The Project would require BLM to grant deviations to BMPs due to technical requirements of the Project and physical constraints of the area that would require essential proposed infrastructure to cross identified setbacks. Deviations from NPR-A BMPs for action alternatives are described in Section 4.2.12, *Compliance with Bureau of Land Management Stipulations, Best Management Practices, and Supplemental Practices*, of Appendix D, *Alternatives Development*.

The 2013 NPR-A IAP/EIS ROD not only describes the protective measures that would be required for the Project, but also stipulates that proponents shall assess the effectiveness of project designs and required mitigations in protecting resources. This effectiveness monitoring is essential to successful mitigation and adaptive management.

5.2.2 Design Features to Avoid and Minimize Impacts

The Project includes design features intended to avoid or minimize impacts that result in environmental harm consistent with the BLM's management practices in the NPR-A. The Proponent design features are listed in Table I.1.2 in Appendix I.1; the measures are part of the Project and were used to evaluate the impacts described in Chapter 3.0, *Affected Environment and Environmental Consequences*. The Proponent may propose additional measures in subsequent permitting phases.

In addition to the measures listed in Appendix I.1, CPAI considered 22 separate gravel-road segment alignments during the preliminary design process, to avoid and minimize Project impacts. As described in Appendix I.2, *ConocoPhillips Road Optimization Memorandum*, these road segments were evaluated based on the following key considerations:

- Minimize the overall gravel footprint (e.g., length of roads, size of pads) and use higher and drier ground where possible to avoid wetlands and other WOUS
- Minimize impacts to caribou migration
- Avoid and minimize encroachments into established waterbody setbacks, particularly Fish (Uvlutuuq) Creek and Judy (Iqalliqpik) Creek setbacks
- Locate waterway crossings to minimize the crossing length and number of bridge piles below OHW
- Avoid and minimize encroachments of yellow-billed loon nest setbacks
- Minimize the Project footprint in the Teshekpuk Lake Caribou Habitat Area

Drill site locations were also optimized using the above considerations. These sites are relatively constrained by the reservoir location, however, CPAI was able to make some minor refinements to avoid and minimize impacts. For example, one of the drill sites (BT4) was initially located in the Teshekpuk Lake Caribou Habitat Area, but after further design refinement, CPAI was able to move that drill site east to avoid this area. CPAI also realigned the road to BT4 to avoid the Teshekpuk Lake Caribou Habitat Area (BLM BMP K-5).

CPAI proposed locating the WPF as far south and west as possible under Alternative B. The intent of this was to construct the WPF in a location where it could potentially be used for future projects CPAI may develop (to the south and west of the Project, where CPAI owns leases though there are no current development plans). This location could minimize future (cumulative) impacts related to further development to the west of the Project area.

5.2.3 Additional Suggested Best Management Practices or Mitigation

In addition to project design features, BLM LSs and BMPs already applicable to the Project, Chapter 3.0 also considers additional suggested BMPs or mitigation measures designed to further avoid, reduce, or compensate for impacts from the Project. These measures are discussed in the relevant resource sections in Chapter 3.0 and are summarized in Table I.1.2 in Appendix I.1. They were developed based on suggestions from cooperating agencies, stakeholders, and BLM staff. Except where otherwise eliminated from further consideration, the decision whether to adopt each new BMP or mitigation measure will be made in BLM's Willow MDP ROD.

Additionally, BLM finalized its Regional Mitigation Strategy (RMS) for Northeastern NPR-A in August 2018 (BLM 2018c). The goal of the RMS is to "serve as a roadmap for mitigating impacts from oil and gas development projects enabled or assisted by the existence of GMT-1." The RMS is intended to help the BLM manage the NPR-A in a manner consistent with public law and to fulfill the requirements of NEPA. The RMS describes current and potential future mitigation actions or opportunities that should be considered when approving an application for development. The Willow MDP ROD will identify mitigation measures that incorporate recommendations made in the RMS.

5.3 Compensatory Mitigation

The BLM considers other compensatory mitigation programs applicable to the Project and Project area in its determination of the appropriateness of compensatory mitigation for impacts from the Project that are expected to persist after the adoption of measures aimed at avoiding, minimizing, or reducing such impacts, including USACE's compensatory mitigation program under Section 404 of the CWA and the State's NPR-A Impact Mitigation Fund Program.

5.3.1 State of Alaska National Petroleum Reserve in Alaska Impact Mitigation Program

The NPR-A Impact Mitigation Fund was created in the early 1980s to provide eligible municipalities with grants to help mitigate significantly adverse impacts related to oil and gas development within the NPR-A. Revenues from oil and gas development within the NPR-A are paid to the U.S. Treasury, which then pays 50% of the revenues to the State. The NPR-A Impact Mitigation Fund is managed by the Department of Commerce, Community and Economic Development under AS 37.05.530 and requires annual reports to the Alaska Legislature, including the history of the program and a list of all grantees, projects, and amounts granted by the State since the program began receiving money in fiscal year 1983. The federal government has no ability to influence the management of the fund or State-run grant program. Activities that are eligible to receive NPR-A grant funding from the State are limited to three categories:

1. Planning
2. Construction, maintenance, and operation of essential public facilities
3. Other necessary public services provided by a municipality

Many subsistence projects are funded as "planning" or "other necessary public services." Fund levels change annually as they are based on lease sales and production royalties.

Grant priority is given to the communities most directly or severely impacted by oil and gas development. This has historically meant those communities located within the NPR-A: Utqiaġvik (Barrow), Atqasuk, Nuiqsut, Anaktuvuk Pass, and Wainwright. Because the NSB is an umbrella organization that has received and distributed a significant percentage of this grant money, all NSB communities have indirectly experienced results of funding, including Kaktovik, Point Lay, and Point Hope. Tribal governments are not municipalities and are not authorized to submit applications to the Impact Mitigation Fund Program.

The State Division of Community and Regional Affairs has an application selection committee made up of three people familiar with issues in NPR-A communities. The committee scores and ranks proposals and provides that list to its commissioner to determine which projects to fund.

Examples of North Slope projects funded by the NPR-A Impact Mitigation Fund include:

- Natural gas distribution system in Nuiqsut

- Village power plants and electrical distribution
- Police officers in villages
- Upgrades to search and rescue equipment
- Renovations or additions to community centers

To date, the State has awarded $203 million in funding for such projects. Total estimated cumulative state royalties from the Project would be $2.5 billion under all action alternatives (NEI 2019).

5.3.2 Compensatory Mitigation for the Fill of Wetlands and Waters of the U.S.

In accordance with 33 CFR 332.1(c)(3), "compensatory mitigation for unavoidable impacts may be required to ensure that an activity requiring a section 404 permit complies with the Section 404(b)(1) Guidelines." Pursuant to this authority, the USACE may require compensatory mitigation for the direct and/or indirect losses of aquatic resources. Mitigation measures required by USACE will be described in its ROD for this EIS.

5.4 Proponent's Voluntary Mitigation

CPAI also provides voluntary mitigation to offset impacts from all CPAI developments in the Nuiqsut area (not the Willow Project alone). These efforts are summarized below.

- Providing the City of Nuiqsut access to a grant writer to assist with grant proposals, which could increase the local understanding that mitigation funds are available and decrease some concerns over the impacts of the Project.
- Providing funding for accounting support, which is critical to successfully managing grant money.
- Continuing to provide resources, access, or services from CPAI North Slope developments to residents of Nuiqsut through the CPAI philanthropy program. The philanthropy program includes:
    - providing natural gas to the community of Nuiqsut,
    - providing annual grants to support the Alaska Eskimo Whaling Commission,
    - providing funds to support administration of the Kuukpikmuit Subsistence Oversight Panel,
    - providing education and workforce development programs (Nuiqsut Trapper School, Ilisagvik College, scholarship funds, and more),
    - funding community projects (such as the Elder's Housing Project, Nuiqsut playground, outdoor basketball court, and early learning center),
    - making donations to the community (including fire trucks, spill response boats, supplies for the teen center, etc.), and
    - providing emergency response assistance to the community of Nuiqsut.

GLOSSARY TERMS

Active layer – The top layer of ground subject to annual thawing and freezing in areas underlain by permafrost.

Alaska water quality standards – A level of water quality established by Alaska Department of Environmental Conservation to protect Waters of the State of Alaska from pollutants; includes designated water use, numeric or narrative parameters for designated use (i.e., criteria), and consistency with the state antidegradation policy.

Albedo – A measure of how a surface reflects incoming radiation; a surface with a higher albedo reflects more radiation than a surface with lower albedo.

Alternatives analysis area – The part of the direct effects analysis area around the onshore action alternatives (excludes the module delivery options).

Anadromous – Fish species that begin their life cycle in freshwater, migrate to salt water, and return to freshwater to spawn (e.g., Pacific salmon).

Anthropogenic – Resulting from the influence of human beings on nature.

Background distance zone – Areas visible within 5 to 15 miles from key observation points.

Benthic – Referring to the area at the bottom of a body of water (such as an ocean or lake), that includes the sediment surface and some subsurface layers.

Best management practice – Mitigation developed through the BLM planning process or NEPA process that is not attached to an oil and gas lease but is required, implemented, and enforced at the operational level for all authorized (not just oil and gas) activities in the planning area. Best management practices are developed with various mechanisms in place to ensure compliance.

Black carbon – A component of fine particulate matter that is formed from incomplete combustion of fossil fuels and biomass.

Bottom-fast ice – Ice that is attached to the waterbody or sea floor and is relatively uniform in composition and immobile during winter (also known as bedfast, ground-fast, fast, shorefast, or landfast ice).

Brood-rearing – After hatch, the season when young birds grow and develop flight capability and are cared for by one or both parents; this life stage spans June (for some early nesting passerines and goose) through August.

Carbon dioxide equivalent – The amount of greenhouse gases that would have an equivalent global warming potential as carbon dioxide when measured over a specific timescale.

Critical habitat – Geographic areas that contain features essential to the conservation of an endangered or threatened species and may require special management and protection. Critical habitat is federally designated.

Designated use – Uses specified by ADEC as protected for each waterbody or water segment, regardless of whether those uses are being attained.

Direct effects analysis area – All subsistence use areas within 2.5 miles of Project infrastructure.

Discharge – The rate at which a given volume of water passes a given location within a specific period of time (e.g., cubic feet per second or gallons per minute).

Distance zones – The level of visibility and distances from important viewer locations, including travel routes, human use areas, and observation points. Distance zones consist of foreground-middleground (0 miles to 5 miles), background (5 miles to 15 miles), and seldom seen (not visible or beyond 15 miles). The Project's estimated nighttime lighting conditions are determined by the heights of drill rigs and communications towers. The Project would be visible out to 30 miles, based on the direct line-of-sight limits due to the curvature of the earth and regional atmospheric conditions.

Dust shadow – The area of deposition by airborne dust around gravel infrastructure.

Eolian – Produced by the wind.

Fall-staging – Season when birds are feeding to build fat reserves for migratory flights and when many species gather into flocks before migration; for most North Slope species, fall-staging occurs in August and September, although shorebirds may start forming flocks in July.

Foreground-middleground distance zone – Areas visible within less than 5 miles from key observation points.

Frac-out – An event during horizontal directional drilling when drilling fluids (mud) used to lubricate the borehole below the streambed are unintentionally released into the stream through fractures in the bore hole.

Greenhouse gases – Gaseous compounds, including carbon dioxide, methane, and nitrous oxide, among others, that block heat from escaping to space and warm the Earth's atmosphere.

Household – One or more individuals living in one housing unit, whether or not they are related.

Hydrologic Unit Code – A U.S. Geological Survey-based system of organizing watersheds using a sequence of numbers or letters to identify a watershed. As the numbers used to describe a watershed increase, the size of the watershed decreases.

Ice exclusion process – The process during the growth of ice by which small molecules are retained in the ice and larger molecules are preferentially excluded, thus concentrating dissolved inorganic ions and organic matter in the unfrozen water below the ice.

Impulsive Noise – Short-term or instantaneous noise events with a steep rise in sound level to a high peak followed by a rapid decay.

Invasive species – Species nonnative to a given ecosystem and whose introduction is likely to cause economic or environmental harm or harm to human health (EO 13112).

Kernel distribution – Kernel distribution or density is a statistical way to estimate the probability of density of a given variable in a defined area. In this case, locations of radio-collared caribou were used to estimate the spatial pattern of seasonal caribou distribution based on the location of radio-collared individuals.

Key observation points – One or a series of points on a travel routes or at a use area or potential use area. This includes points with views of the Project that were identified based on areas of high visual sensitivity, angle of observation, number of viewers, public access, length of time the Project is in view, relative project size, season of use, and light conditions.

Lacustrine – Produced or originating from or within a lake.

Lake-tapping – Sudden drainage of lakes caused by ice melting or dislodging and opening up a drainage channel.

Lease stipulations – Mitigation developed through BLM planning process or NEPA process that is specifically attached to a lease.

Legacy well – Exploratory and scientific wells drilled between 1944 and 1982 by the U.S. Navy and U.S. Geological Survey within the NPR-A in which the BLM now has the responsibility to asses, plug, and clean up (BLM 2013a).

Medevac – The transport of someone to a hospital via helicopter or airplane.

Molting – Molt is the annual replacement of feathers; it is an important period for waterfowl because they become flightless until wing feathers are replaced. Molt occurs during mid- to late-summer after nesting and during the brood-rearing period.

Nesting – Season when birds are building nests and incubating eggs, which for most birds on Alaska's North Slope, spans from late May through July.

Noise-sensitive receptors – People and areas of human activity that may be particularly affected by high levels of noise (e.g., residences, hospitals, schools, etc.).

Non-impulsive noise – Longer term, continuous, varying, or intermittent noise events.

Overland flow – The flow of rainwater or snowmelt over the land surface toward stream channels.

Permafrost – Ground with subfreezing temperatures for at least two consecutive years.

Pigging – Mechanical devices (i.e., pigs) used in pipeline monitoring and maintenance which are capable of inspecting pipeline conditions and cleaning pipelines.

$PM_{2.5}$ – Particulate matter less than 2.5 microns in aerodynamic diameter in ambient air; this fraction of particulate matter penetrates most deeply into the lungs.

PM_{10} – Particulate matter less than or equal to 10 microns in aerodynamic diameter in ambient air, which causes visibility reduction or potential adverse health effects; a criteria air pollutant.

Pre-breeding – Equivalent to pre-nesting. Period immediately prior to nesting when nesting habitats are becoming available after snowmelt or flooding, and birds are dispersing into nesting areas, generally in late May for early nesting species and in early June for most species on the ACP.

Reservoir blowout – The uncontrolled release of produced fluids or natural gas (or both) when target oil reservoir pressures are much higher than anticipated and planned for (also known as a well blowout).

Resistant fish – Fish that are resistant to the potential changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, as per BMP B-2, as well as ADNR and ADF&G permit stipulations. These species are ninespine stickleback and Alaska blackfish.

Scenic quality – The relative worth of a landscape from a visual perception point of view expressed as a quantitative measure of qualitative criteria associated with landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications (BLM 2012a).

Screeding – A process which recontours sediment on the marine floor but does not remove sediment from the water. The activity often entails dragging a metal plate such as a screed bar across the sediment, thereby smoothing the high spots and filling the relatively lower areas. The amount of material moved is generally small and localized and the result is a flat seafloor within the work area. Screeding is necessary to temporarily ground the sealift barges during module offloading; a flat seafloor provides stability and prevents damage to the barge hulls during grounding.

Seldom seen – Areas within the foreground-middleground and background distance zones that are not visible, or areas that are visible but are beyond the background zone (more than 15 miles from key observation points).

Sensitive fish – Fish that are sensitive to the potential changes in water quality, such as reduced dissolved oxygen and increased dissolved solids, as per BMP B-2, as well as ADNR and ADF&G permit stipulations. All species documented from the fish analysis area are sensitive except ninespine stickleback and Alaska blackfish.

Sensitivity level – The measure of public concern for scenic quality (as determined through the Visual Resource Inventory process).

Shallow-gas blowout – The uncontrolled release of natural gas (and drilling mud) when shallow, high-pressure gas deposits are unexpectedly encountered beneath the surface and above the target oil reservoir depth.

Special Recreation Permits – Permits issued by BLM to businesses, organizations, and individuals to allow the use of specific public land and related waters for commercial, competitive, and organized group use. The permits allow BLM to track commercial and competitive use of public lands, and provide resource protection measures to ensure the future enjoyment of those resources by the public.

Stage – The vertical height of the water above an established but usually arbitrary point. Sometimes zero stage corresponds to the riverbed but more often to just an arbitrary point.

Subsistence – A traditional way of life in which wild renewable resources are obtained, processed, and distributed for household and community consumption according to prescribed social and cultural systems and values.

Subsistence use areas – The geographic extent of a resident's or community's use of the environment to conduct traditional subsistence activities.

Talik – A layer of year-round unfrozen ground that lies in permafrost areas and often forms beneath lakes and rivers too deep to completely freeze during the winter; also referred to as a thaw bulb.

Thaw bulb – A layer of year-round unfrozen ground that lies in permafrost areas and often forms beneath lakes and rivers too deep to completely freeze during the winter.

Thermokarst – A land surface with karst-like features and hollows produced by melting of ice-rich soil or permafrost.

Viewshed – The total landscape seen from a point, or from all or a logical part of a travel route, use area, or water body.

Visual Resource Inventory – The process of determining the visual value of BLM-administered lands through the assessment of the scenic quality rating, sensitivity level, and distance zones of visual resources within those lands.

Visual Resource Inventory classes – Four visual resource inventory classes into which all BLM-administered lands are placed based on scenic quality, sensitivity levels, and distance zones, as determined through the Visual Resource Inventory process.

Visual Resource Management classes – Categories assigned to public lands based on scenic quality, sensitivity level, and distance zones with consideration for multiple-use management objectives. There are four classes; each class has an objective that prescribes the amount of change allowed in the characteristic landscape. Visual resource management classes are assigned through BLM Resource Management Plans (in this case, the IAP for the NPR-A).

Visual Resource Management system – The system used by the BLM to manage visual resources (including in the NPR-A). It includes inventory and planning actions to identify visual values and to establish objectives for managing those values.

Visual resources – Visible features and objects, natural and man-made, moving and stationary, which comprise the character of the landscape observed from a given location or key observation point.

Water quality criteria – Numeric or narrative parameters established to protect designated uses.

Water surface elevation – The elevation of the water surface of a river, lake, or stream above an established reference or vertical datum.

Waters of the United States – Waterbodies and wetlands under jurisdiction of the USACE, as defined by 33 CFR 328.3.

Well blowout – See reservoir blowout.

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